PB-213 119

GUIDELINES FOR EROSION AND SEDIMENT CONTROL PLANNING AND IMPLEMENTATION

Burton C. Becker, et al

Hittman Associates, Incorporated
Columbia, Maryland

August 1972

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5285 Port Royal Road, Springfield Va. 22151

EPA-R2-72-015
August 1972
W73-01773

PB 213 119

Environmental Protection Technology Series

Guidelines for Erosion and Sediment Control Planning and Implementation

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U S Department of Commerce
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SELECTED WATER RESOURCES ABSTRACTS

INPUT TRANSACTION FORM

1. *Report No.*

2.

16

3. *Accession No.* **W**73-01723

4. *Title*

GUIDELINES FOR EROSION AND SEDIMENT CONTROL PLANNING AND IMPLEMENTATION,

5. *Report Date*

6.

8. *Performing Organization Report No.*

7. *Author(s)*

Becker, B. C., and Mills, T. R.

10. *Project No.* EPA

15030FM~~Z~~2

9. *Organization*

Maryland Dept of Water Resources, Annapolis, and
Hittman Associates, Inc, Columbia, Md

11. *Contract/Grant No.*

13. *Type of Report and Period Covered*

12. *Sponsoring Organization*

14. *Supplementary Notes*

Environmental Protection Technology Series ~~Agency Office of Monitoring and Research Report~~
EPA-R2-72-015., August 1972. 228 p, 140 fig, 5 ref. EP1.23/2:72-015

16. *Abstract*

This is the first of three major documents as part of "Joint Construction Sediment Control Project"being conducted in Columbia, Maryland. This project is operated by the Maryland Department of Water Resources under an Environmental Protection Agency grant. The principal purpose of the guidelines is to help those engaged in urban construction, prevent the uncontrolled movement of soil and the subsequent damage it causes. A comprehensive approach to the problem of erosion and sediment control provides: (1) A description of how a preliminary site evaluation determines what potential sediment and erosion control problems exist at a site being considered for development, (2) Guidance for the planning of an effective sediment and erosion control plan, and (3) Procedures for the implementation of that plan during operations. Technical information on 42 sediment and erosion control products, practices, and techniques is contained in four appendices. In addition, a cross-index and a glossary of technical terms used in the document are provided. (Woodard-USGS)

17a. *Descriptors*

*Sediment control, *Erosion control, *Urbanization, *Urban hydrology, *Land management, Maryland, Land development, Construction, Building codes, Road construction, Cities, Soil conservation, Planning, Water control, Soil erosion, Sediment transport

17b. *Identifiers*

Erosion control guidelines

17c. *COWRR Field & Group* 04C, 04D, 02J 05G

Copy available from GFO Sup Doc
, $ 1.75 ; microfiche
from NTIS as PB 213 119, $0.95.

18. *Availability*

19. *Security Class. (Report)*

20. *Security Class. (Page)*

21. *No. of Pages*

22. *Price* -19-

Send To:

WATER RESOURCES SCIENTIFIC INFORMATION CENTER
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D. C. 20240

Abstractor T. H. Woodard, 10/4/72

Institution U.S. Geol. Survey, Water Res. Div.

EPA-R2-72-015
August 1972

GUIDELINES FOR EROSION AND SEDIMENT CONTROL PLANNING AND IMPLEMENTATION

G.S.)W
10)EPA

Details of illustrations in this document may be better studied on microfiche.

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Project 15030 FMZ

Prepared for

OFFICE OF RESEARCH AND MONITORING
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $1.75

EP 1.23/2:72-015

EPA Review Notice

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ABSTRACT

"Guidelines for Erosion and Sediment Control Planning and Implementation" is the first of three major documents being generated as part of the "Joint Construction Sediment Control Project" being conducted in Columbia, Maryland. This project is being operated by the Maryland Department of Water Resources under an Environmental Protection Agency grant.

The principal purpose of the "Guidelines" is to help those responsible for, or engaged in, urban construction prevent the uncontrolled movement of soil and the subsequent damage it causes. The "Guidelines" presents a comprehensive approach to the problem of erosion and sediment control from beginning of project planning to completion of construction. It provides:

(1) A description of how a preliminary site evaluation determines what potential sediment and erosion control problems exist at a site being considered for development

(2) Guidance for the planning of an effective sediment and erosion control plan

(3) Procedures for the implementation of that plan during operations

Technical information on 42 sediment and erosion control products, practices, and techniques is contained in four appendices. In addition, a cross-index and a glossary of technical terms used in the document are provided.

The "Guidelines" is designed and intended for use by both technical and lay personnel.

CONTENTS

Section | Page
I Introduction 1
II Preliminary Site Evaluation 5
  A General 5
  B Maps and Airphotos 5
  C Soils and Geological Information 6
  D Technical Assistance 8
  E Evaluation of Prime Physical Features 9
    1 Land Type 9
    2 Soil and Rock 13
    3 Streams 13
    4 Floodplains 16
    5 Impoundments 17
    6 Groundwater Conditions 17
    7 Vegetative Cover 17
III Planning 19
  A General 19
  B Preliminary Site Investigation 19
    1 Delineation of Critical and Prime Physical Features 19
    2 Detailed Topographic Mapping 20
  C Preliminary Design 20
  D Subsurface Investigation 21
    1 Vegetative Stability 21
    2 Soil Erodibility 23
    3 Soil Chemistry 23

CONTENTS
(Continued)

Section			Page
	4	Groundwater	23
	5	Topsoil	24
	E	Final Design	24
	1	Stabilization of Major Waterways	24
	2	Stabilization of Minor Waterways	32
	3	Stabilization of Soil Slopes	35
	F	Formulation of Erosion and Sediment Control Plan	41
	1	Clearing and Grading Schedule	42
	2	Location, Construction, and Maintenance of Sediment Retention Structures	44
	3	Traffic Control	44
	4	Stream Erosion	45
	5	Planting Schedule	45
	6	Grading Delays	45
IV		Operations	47
	A	General	47
	B	Roadway Construction	47
	C	Underground Utility Construction	49
	D	Building Construction	51
V		Maintenance	57
VI		Acknowledgment	59
VII		References	61
VIII		Glossary	63

CONTENTS
(Continued)

Section			Page
IX	Appendices		77
	A	Chemical Soil Stabilizers, Mulches, and Mulch Tacks	78
	B	Erosion and Sediment Control Structures	97
	C	Fiber Mulches, Mulch Blankets, and Netting	163
	D	Special Erosion and Sediment Control Practices	193

FIGURES

		PAGE
1	BARREN AREA	9
2	AGRICULTURAL AREA	10
3	WOODLAND AREA	11
4	WOODLAND AREA - MATURE STAND	11
5	WOODLAND AREA - POLE STAND	12
6	WOODLAND AREA - MIXED STAND	12
7	CHANNEL LINED WITH HAND PLACED ROCK	14
8	FLOODPLAIN IN DEVELOPED AREA	16
9	GROUNDWATER TABLE EXPOSED IN A BASEMENT EXCAVATION	18
10	WELL ESTABLISHED VEGETATION IN A MINOR DRAINAGEWAY	18
11	NATURAL FILTER STRIP SEPARATING BARE SOIL (FOREGROUND) FROM A STREAM CHANNEL (DARK VEGETATION IN MIDDLEGROUND)	21
12	VEGETATIVE STREAMBANK STABILIZATION	26
13	CHECK DAM WITH ENERGY DISSIPATOR	28
14	COMBINATION OF CHECK DAMS AND LINED CHANNEL	28
15	CHECK DAMS (WEIRS) CONSTRUCTED OF WOOD	29
16	SACKED CONCRETE REVETMENT	30
17	JUTE NETTING BEING USED IN WATERWAY STABILIZATION	34
18	DIVERSIONS BEING USED TO CONTROL DOWNSLOPE RUNOFF	36
19	CHEMICAL MULCH TACK BEING APPLIED	40

FIGURES
(Continued)

		PAGE
20	FILTER BERM	42
21	EXAMPLE OF A SEDIMENT AND EROSION CONTROL PLAN	43
22	EROSION ALONG AN IMPROPERLY BACKFILLED UTILITY TRENCH	49
23	FIREWOOD PRODUCED DURING CLEARING OPERATIONS	52
24	USE OF WOODCHIPS AS AN INTERIM EROSION CONTROL PRACTICE ON A HOMESITE	52
25	SELECTIVE STOCKPILING TO PROTECT TREES	53
26	STOCKPILE WITH A NATURAL FILTER STRIP LOCATED DOWNSLOPE	54
27	EROSION AT AN UNPROTECTED DRIPLINE	56
28	DRIPLINE PROTECTION WITH A FIBER GLASS BLANKET	56
A-1	CHEMICAL SOIL STABILIZER BEING APPLIED TO AN AREA THAT WILL BE SEEDED AT A LATER DATE	79
A-2	CHEMICAL MULCH TACK BEING APPLIED TO STRAW MULCH	79
A-3	CHEMICAL MULCH BEING APPLIED IN A HYDROSEEDER SLURRY WITH LIME, FERTILIZER, AND SEED	80
B-1	CHECK DAMS CONSTRUCTED OF GABIONS AND ROCK RIPRAP	99
B-2	ROCK AND WOOD CHECK DAM	99
B-3	CHUTE/FLUME	102
B-4	FLUME WITH ENERGY DISSIPATORS	103

FIGURES
(Continued)

		PAGE
B-5	CONCRETE CHUTE	103
B-6	CONCRETE CHUTE	104
B-7	DIVERSION DIKE	106
B-8	DIVERSION DIKE AT TOP OF SLOPE	107
B-9	DIVERSION DIKE CONSTRUCTED BY DOZER MOVING SOIL UPSLOPE AND DUMPING AT TOP OF SLOPE	107
B-10	DIVERSION ON A STABILIZED SLOPE	108
B-11	EROSION CHECK	111
B-12	FIBER GLASS EROSION CHECK IN TRENCH - AWAITING BACKFILL	112
B-13	FIBER GLASS EROSION CHECK AND WELL ESTABLISHED VEGETATION	112
B-14	FABRIFORM® MAT IN PLACE, AWAITING FILLING	116
B-15	COMPLETED FABRIFORM® (FILTERPOINT) STRUCTURE	116
B-16	FABRIFORM® CHANNEL LINING BEING FILLED	117
B-17	FABRIFORM® CHANNEL LINING BEING FILLED NOTE UNINTERRUPTED STREAM FLOW	117
B-18	FABRIFORM® (UNIFORM CROSS SECTION) CHECK DAM	118
B-19	FILTER BERM	120
B-20	FILTER BERM - INSTALLED	121
B-21	FILTER BERM - INSTALLED	121
B-22	FILTER INLET	124
B-23	FILTER INLET - INSTALLED	124

FIGURES
(Continued)

B-24	FILTER INLETS - INSTALLED	125
B-25	FILTER INLET REQUIRING MAINTENANCE	125
B-26	FILTER INLET	126
B-27	FILTER INLET - INSTALLED	126
B-28	FLEXIBLE DOWNDRAIN	129
B-29	FLEXIBLE DOWNDRAIN - ISOMETRIC	130
B-30	FLEXIBLE DOWNDRAIN - INSTALLED	130
B-31	FLEXIBLE DOWNDRAIN INLET STRUCTURE	131
B-32	GABIONS - CHANNEL BANK PROTECTION	133
B-33	GABIONS - CHANNEL BANK PROTECTION	133
B-34	GABIONS - PROTECTION AT STREAM BEND	134
B-35	GABIONS - CHANNEL LINING, CHECK DAM AND BANK PROTECTION	134
B-36	INTERCEPTOR DIKE	137
B-37	INTERCEPTOR DIKE - INSTALLED AND OUTLETTING TO STORM SEWER INLETS	138
B-38	INTERCEPTOR DIKE - INSTALLED	138
B-39	LEVEL SPREADER	141
B-40	SANDBAGS AT SITE FOR CONSTRUCTION OF SEDIMENT CONTROL STRUCTURE	143
B-41	SANDBAG STRUCTURE IN PLACE	143
B-42	SECTIONAL DOWNDRAIN	146
B-43	SECTIONAL DOWNDRAIN USED AS A DITCH LINER	146
B-44	SECTIONAL DOWNDRAIN	147
B-45	SEDIMENT RETENTION STRUCTURE - SMALL, LESS THAN 1/4-ACRE	155

FIGURES
(Continued)

		PAGE
B-46	SEDIMENT RETENTION STRUCTURE - LARGE, 4 ACRES. WILL BE CONVERTED FOR RECREATIONAL USE AFTER DEVELOPMENT IS COMPLETE	156
B-47	SEDIMENT RETENTION STRUCTURE - 1 ACRE	156
B-48	SEDIMENT RETENTION STRUCTURE. MAINTENANCE PAST DUE	157
B-49	SEDIMENT RETENTION STRUCTURE NOW REQUIRING MAINTENANCE (CLEANOUT)	157
B-50	STRAW BALE STRUCTURE AT STORM DRAIN INLET	160
B-51	STRAW BALE STRUCTURE AT SEDIMENT RETENTION STRUCTURE (TIDAL)	160
B-52	STRAW BALE STRUCTURE ON PROPERTY LINE	161
B-53	STRAW BALE STRUCTURE AT STORM DRAIN INLET	161
C-1	EXCELSIOR BLANKET AND STAPLE	165
C-2	DRIVING STAPLE TO ANCHOR EXCELSIOR BLANKET	166
C-3	FIBER GLASS MAT AT CULVERT INVERT	168
C-4	GLASSROOT® APPLICATION	170
C-5	GLASSROOT® IN PLACE	170
C-6	GLASSROOT® IN PLACE. VEGETATION STARTING	171
C-7	JUTE NETTING BEING INSTALLED	174
C-8	JUTE NETTING - CLOSE UP	174
C-9	JUTE NETTING OVER STRAW MULCH IN A DRAINAGEWAY	175
C-10	MULCH BLANKET BEING INSTALLED	177

FIGURES
(Continued)

		PAGE
C-11	MULCH BLANKET BEING STAPLED	178
C-12	PLASTIC NET OVER FIBER GLASS ROVING - CLOSEUP	180
C-13	PLASTIC NET (ON ROLL) READY FOR INSTALLATION IN CRITICAL AREA	181
C-14	STRAW MULCH BEING APPLIED BY MULCH BLOWER	184
C-15	LARGE STRAW MULCHING OPERATION	184
C-16	ASPHALT BEING USED TO TACK STRAW MULCH	185
C-17	WOODCHIPS - APPLICATION RATE IS 4 CUBIC FEET PER 100 SQUARE FEET OF AREA	187
C-18	WALKWAY OF WOODCHIPS	188
C-19	SPREADING WOODCHIPS ON HOME SITE	188
C-20	WOODFIBER (SHORT FIBER) BEING APPLIED IN HYDROSEEDER SLURRY	191
C-21	WOODFIBER MULCH IN PLACE (CLOSEUP)	192
D-1	WATER BEING PUMPED FROM AN EXCAVATION AND BEING DISCHARGED ONTO A SPOIL PILE	197
D-2	SAME AREA AS FIGURE D-1. PUMPED WATER SHOULD BE DISCHARGED TO COMPLETED STORM DRAIN	197
D-3	PUMPED WATER BEING DISCHARGED TO STABLE AREA (SURFACED STREET) RATHER THAN TO BARE SOIL	198
D-4	SCARIFICATION UP AND DOWN SLOPE AIDS EROSION	200
D-5	SCARIFICATION ACROSS SLOPE AIDS EROSION CONTROL	201

FIGURES
(Continued)

		PAGE
D-6	SERRATED CUT - A TYPE OF ROUGHENED SLOPE	201
D-7	SCARIFICATION ON SLOPE BEHIND HOMESITES	202
D-8	STUMP CUTTER	204
D-9	STUMP CUTTER REMOVING STUMP	204
D-10	STUMP PARTIALLY REMOVED BY STUMP CUTTER	205
D-11	RILLS IN EQUIPMENT TRACKS	208
D-12	ROAD COMPLETELY CLOSED BY SANITARY SEWER CONSTRUCTION	208
D-13	TWO ROUTES (ONE IS CONVENIENCE ROUTE) TO SAME LOCATION	209
D-14	AREA COMPLETELY DENUDED BY EQUIPMENT TRAVEL	209
D-15	"CONVENIENCE" ROUTE THROUGH A STAND OF TREES MARKED FOR PRESERVATION	210
D-16	INCORRECT FENCING FOR TREE PROTECTION	213
D-17	CORRECT FENCING FOR TREE PROTECTION	213
D-18	CORRECT FENCING FOR TREE PROTECTION	214
D-19	TREE PROTECTION - SELECTIVE STOCKPILING SOIL FROM BASEMENT EXCAVATION	214
D-20	TREE PROTECTION - TILE AND GRAVEL WILL ALLOW AIR CIRCULATION TO ROOT ZONE UNDER A FILL	215
D-21	TREE PROTECTION - TUNNELING	216
D-22	SOD FILTER STRIP ON STOCKPILE FOR WINTER PROTECTION	219

FIGURES
(Continued)

		PAGE
D-23	SOD FILTER STRIP AND STRAW BALES ON STOCKPILE FOR WINTER PROTECTION	219
D-24	SOD FILTER STRIP AT STORM DRAIN INLET	220
D-25	SEDIMENT DEPOSITION AT SOD FILTER STRIP	220
D-26	TREES MARKED FOR PRESERVATION	224
D-27	TAKING DOWN A TREE AFTER HOME CONSTRUCTION. TREE IS TOO CLOSE TO HOUSE AND SHOULD HAVE BEEN REMOVED WHEN LOT WAS CLEARED SINCE ITS ROOT SYSTEM HAS BEEN SEVERELY DAMAGED BY EXCAVATION FOR A BASEMENT	224
D-28	TREE WITH VISIBLE DAMAGE. EXISTING DAMAGE SHOULD BE ASSESSED WHEN SELECTING TREES FOR REMOVAL OR PRESERVATION	225
D-29	SECTION OF TREE TRUNK (FIGURE D-28) AFTER REMOVAL. NOTE DAMAGE CAUSED BY CARPENTER ANTS	225
D-30	EQUIPMENT TRAVEL IN THIS AREA HAS SERIOUSLY DAMAGED ROOT SYSTEMS OF TREES MARKED FOR PRESERVATION	226
D-31	ACCESS ROUTE FOR MATERIAL DELIVERY TO BASEMENT HAS CUT ROOTS OF BEECH TREE ON LEFT	226
D-32	WOODCHIPS BEING RETURNED TO FOREST	227
D-33	WOODCHIPPER BEING FED	227
D-34	DRAINAGE DITCH FOR "CONVENIENCE" OF UTILITY CONSTRUCTION HAS BEEN CUT ON PRIVATE PROPERTY WELL OUTSIDE OF RIGHT-OF-WAY	228

CROSS-INDEX

A Chemical Soil Stabilizers, Mulches, and Mulch Tacks - pp. 22, 38, 39, 40, 48, 50, 51, 53, 55, 78

Aerospray® 52 Binder - pp. 63, 81

Aquatain - pp. 63, 83

®Curasol AE - pp. 65, 85

®Curasol AH - pp. 65, 87

DCA-70 - pp. 65, 89

Liquid Asphalt - pp. 39, 40, 70, 91

Petroset® SB - pp. 71, 93

Terra Tack - pp. 74, 75, 95

B Erosion and Sediment Control Structures - p. 97

Check Dam - pp. 15, 27, 32, 33, 51, 64, 98

Chutes/Flumes - pp. 37, 51, 58, 64, 67, 101

Diversion Dike - pp. 36, 37, 48, 57, 58, 66, 105

Erosion Check - pp. 35, 67, 109

Fabriform® Erosion Control Mat - pp. 15, 27, 67, 114

Filter Berm - pp. 37, 41, 48, 50, 57, 67, 119

Filter Inlet - pp. 41, 67, 123

Flexible Downdrain - pp. 36, 50, 51, 58, 67, 128

Gabions - pp. 13, 15, 27, 67, 132

Interceptor Dike - pp. 36, 37, 48, 50, 57, 58, 69, 136

Level Spreader - pp. 36, 58, 69, 140

Sandbag Sediment Barrier - pp. 41, 50, 72, 142

Sectional Downdrain - pp. 36, 50, 58, 73, 145

Sediment Retention Basin - pp. 17, 25, 41, 47, 57, 73, 148

CROSS-INDEX
(Continued)

Straw Bale Sediment Barrier - pp. 41, 49, 50, 74, 159

C Fiber Mulches, Mulch Blankets and Netting - p. 163

Excelsior Blanket - pp. 22, 26, 34, 38, 40, 55, 67, 164

Fiber Glass Matting - pp. 34, 38, 55, 67, 167

Glassroot® - pp. 22, 26, 39, 55, 68, 169

Jute Netting - pp. 22, 26, 34, 38, 40, 55, 69, 172

Mulch Blanket - pp. 22, 26, 34, 38, 40, 55, 70, 176

Netting - pp. 26, 35, 38, 40, 55, 70, 179

Plastic Filter Sheet - pp. 24, 71, 182

Straw or Hay - pp. 22, 35, 38, 39, 48, 51, 53, 55, 68, 74, 183

Woodchips - pp. 22, 38, 39, 47, 48, 49, 50, 51, 53, 55, 76, 186

Woodfiber Mulch - pp. 22, 38, 53, 55, 76, 190

D Special Erosion and Sediment Control Practices - p. 193

Construction Coordination - pp. 25, 42, 44, 45, 49, 65, 194

Mulch Anchoring - pp. 22, 38, 39, 48, 50, 51, 55, 70, 195

Pumped Water Management - pp. 50, 72, 196

Roughness and Scarification - pp. 22, 37, 50, 51, 72, 73, 199

Stump Removal - pp. 51, 74, 203

Traffic Control - pp. 32, 44, 48, 49, 50, 53, 58, 75, 206

Tree Preservation - pp. 19, 20, 44, 47, 48, 50, 51, 54, 75, 211

Vegetative Filter Strip - pp. 18, 20, 25, 41, 44, 48, 50, 53, 57, 67, 75, 218

Woodland Clearing and Excavation - pp. 44, 47, 50, 76, 222

SECTION I

INTRODUCTION

The development of technology for the control of erosion and sediment has been underway since the federal government became involved with the problems associated with the drought of the "dirty thirties." Problems were defined and practices were developed for their control. Implementation began on a formal basis with the help of the Civilian Conservation Corps, the Soil Erosion Service, etc. Over the years conservation practices were developed. Terraces, grassed waterways, contour farming, strip cropping... were put into use on farms across the United States because the continued productivity of the soil could be assured and crop yields very often could be improved by the use of good conservation practices.

With the post World War II building boom came intensive concentrations of people in and around established cities. "Suburbs," "suburbia," "suburbanites"... were added to the American vocabulary and urban sprawl became a part of the American way of life.

As the concentration of people in and around the cities became more intense, concern for the environment became a topic of conversation. With the passage of time individuals began to seek ways to protect the environment. Groups of concerned citizens became active and their efforts became widely publicized. The legislative, executive, and judicial branches of local, state, and federal government became more involved with each passing year.

With the advent of the 1960's, ecology and the environment were being considered major issues. Human energy and dollar resources began to be expended to slow the general environmental degradation that was now so apparent. Surface mining of natural resources, manufacturing, power generation, urban development, etc., were now being asked and required to adjust their priorities and modes of operation in an effort to decrease the rate of environmental decay.

The problems caused by ineffective erosion and sediment control from urban development are similar in some aspects to those which occur with unplanned and poorly managed use of land for agriculture. For example, reducing the water absorptive and holding capacity of land by removing its natural vegetative cover during land clearing accelerates and increases the volume of runoff water from rain. Streams receiving this runoff can swell to such an extent that their banks are breached. If the runoff is significantly above that which occurs naturally, then there is flooding with the possibility of loss of life. Loss or damage to property can result. Changes in the natural runoff pattern almost always result in scouring and movement of soil. This erosion on land can cause damage to buildings, roads, and bridge foundations. When scoured soil is flushed into streams or lakes, destructive sedimentation occurs. Fish and other aquatic life habitat is damaged or eliminated. The addition of large amounts of sediment to streams fills in deeper channels. Runoff then scours the upper banks of the stream because the stream's capacity has been reduced and the water must rise. This scouring contributes more soil to the stream, compounding the problem.

Many concepts have been generated in an effort to aid in this environmental struggle. Research should lead the fight. Currently, environmental research is obliged to fight "brush fires." A great need exists for applied research that addresses itself toward solution of major problems - problems like sediment and erosion control.

In the middle 1960's, erosion and sediment production associated with urban development became a major concern. Sediment was recognized as a pollutant. Legislation was introduced and, in some cases, passed requiring that urban development implement measures to reduce the ecological and environmental stress imposed by sediment generated on construction sites. Specific problems were defined and practices for their control were developed just as they had been "back in the thirties." However, now the problem was not focused on rural America. It now included the development of "suburbia." New products, techniques, practices, etc., were developed specifically for use on urban development projects. Much of the technological advance has been made by field trial and evaluation on sites under development. Some progress came about by altering methods that had for years successfully performed "on the farm" However, this type of progress is not sufficient. As the technology is advanced, it must also be disseminated. People must be trained to use the new techniques. The public can also expect to make financial sacrifices, and token financial commitment will not suffice. If the environment is to be saved, legal matters must be handled by lawyers who are knowledgeable in the environmental sciences so that they can intelligently argue for its cause. Legislative bodies must formulate and pass workable laws - laws that will and can be funded and enforced. These are only some of the concepts. There are, undoubtedly, many more - all worthy of attention.

These guidelines attest to the fact that the work is underway. It is one of several steps in the general scheme of environmental conservation. But, it is the result of research - applied research that addresses itself to the broad problem of sediment and erosion control. It is also a document that is designed for broad use in the field. It can be used by both the layman and the conservation specialist. It contains information that is applicable to the regional development scheme and the development of a single lot. It is designed for use -- use in the field -- the field of sediment and erosion control.

"Guidelines for Erosion and Sediment Control Planning and Implementation" is the first of three major documents being generated as part of the Joint Construction Sediment Control Project being conducted in the Village of Long Reach, Columbia, Maryland. This project is being operated by the Department of Water Resources, State of Maryland, under an Environmental

Protection Agency demonstration grant. Hittman Associates, Inc., of Columbia, Maryland, is the prime contractor for the project. Howard Research and Development Corporation, the developers of Columbia, the Columbia Parks and Recreation Association, Inc., a nonprofit corporation representing the community used, and various builders are participants in this applied research project.

For the above reasons and others to be explained later, the principal purpose of these guidelines is to help those responsible for, or engaged in, urban construction prevent the uncontrolled movement of soil and the damage it causes. The guidelines can serve those concerned in several ways. First, it can provide guidance in the design and implementation of a complete sediment and erosion plan. It can also be used as a primer for personnel interested in this field. There may be secondary benefits, as well. Avoidance of environmental destruction often can prevent legal action to recover damages. Money can be saved in the overall cost of development and maintenance. More natural and pleasant surroundings will stimulate sales at higher prices and the reputation of those engaged in development will be enhanced.

Instructions For The Use Of These Guidelines

Although it is a bound publication, it can best serve by conversion to looseleaf form. The binding can be removed and it can then be punched for looseleaf use. As a looseleaf document, the new data, innovations, additions, etc., in the field of erosion and sediment control technology that are sure to follow can be easily incorporated into this document.

References used in the preparation of this document are contained in Section VII. Terms used that are technical in nature, or that are not commonly used, are defined in the Glossary, Section VIII. It should be consulted if there is doubt regarding the meaning of a word used in the text or appendices.

A Cross-Index is also provided immediately following the List of Figures. It lists each entry included in the Appendices and those pages upon which the entry is mentioned in the text. Ample space for notes is also provided in the Appendices.

SECTION II

PRELIMINARY SITE EVALUATION

A. General

The preliminary site evaluation is performed prior to the acquisition of a parcel of land. In this evaluation, the physical features of the land are evaluated to determine potential erosional hazards. Based on the information acquired from the preliminary site evaluation, the general requirements needed to avoid or minimize damage to land, water, trees, and other vegetation can be determined.

The preliminary site evaluation should be performed by individuals experienced in the siting and design of both structural and vegetative erosion and sediment control practices. They should also be knowledgeable in the earth and vegetative sciences and be capable of recognizing the critical physical features affecting erosion and sediment control.

As a minimum, the preliminary site evaluation should include a thorough surface reconnaissance of the potential development site and a familiarization with those references which describe the characteristics of the local geology, soil, and hydrology. In the case of development where extensive grading is anticipated, it is also desirable to perform a preliminary subsurface investigation. It will provide information on the geologic, soil, and groundwater conditions that must be considered. Down to a depth of approximately three feet, subsurface information can generally be obtained using a hand auger. For depths between three and ten feet it is generally desirable to use either a standard backhoe or drilling machines. Below 10 feet in depth, it is generally necessary to use drilling machines.

B. Maps and Airphotos

The use of all available topographic, geologic, soils, and zoning maps, and airphotos is essential for a good preliminary site evaluation. To the experienced and trained individual these documents provide a valuable source of information on physical features that relate to erosion and sediment control. In addition, these documents should be used as base maps on which to record the locations of critical physical features and to make preliminary layouts of the potential development.

Maps and airphotos are often available at slight cost from several governmental sources. Probably the most widely used source of topographic maps is the United States Geological Survey, which publishes and sells quadrangle maps. These maps normally have a scale of 1:24,000 (one inch = 2000 feet) and a contour interval of 20 feet. Due

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to their small scale and large contour interval, these maps usually have value only in studying the gross topographic features of large areas involving many acres.

One of the most valuable sources of mapping information for preliminary site evaluation is the local County Soil and Water Conservation District Office. County District Offices are assisted by the Soil Conservation Service of the United States Department of Agriculture and maintain a file of airphotos of their counties which are available for inspection. These airphotos provide a wealth of information important to a preliminary site evaluation. Stereoscopic pairs of airphotos permit the viewing of large areas in three dimensional perspective. As a result, land forms, vegetative features, hydrologic features, and man-made features are clearly visible. Often these photos have been used to prepare a photo mosaic which permits an overall view of the potential development site and shows the relative locations of the various vegetative, drainage, and man-made features. A photo mosaic or orthophotograph is also useful as a base map on which to record the location of critical physical features.

Other important sources of maps are the state geological surveys. They often publish a state geologic map and, in some states, also county geologic maps. These maps show the recognized and inferred rock outcrop areas of the various geologic units and also display gross topographic features. To a geologist, the information found on these maps provides an important insight into recognizing possible limiting physical features related to erosion and sediment control. For most developments, these maps would not be an important source of topographic information because of their small scale.

County highway and planning and zoning maps are also often available and useful in developing the information required for a preliminary site evaluation.

Inquiries should be made into the regulations and restrictions that apply to the development of property. This inquiry should be made early in the preliminary survey in order that the proposed development plans can be formulated to comply with the law. Information regarding legislation that may be pending should also be acquired since the proposed development may be influenced by legislative enactment.

Agencies at the federal, state, county, municipal, etc., levels should be contacted for specific information on legislation governing development in the area being considered.

C. Soils and Geological Information

In addition to the various types of maps, several publications that provide general information on local soil and geologic conditions are available to the engineer and scientist making a preliminary site evaluation.

The most useful publications that are generally available for public use are the county soil survey reports, prepared and published by the Soil Conservation Service of the United States Department of Agriculture in cooperation with state agricultural experimental stations. The reports which have been published within the last few years contain considerable amounts of information pertinent to erosion and sediment control evaluations. For example, they contain photo mosaics, generally printed at a scale of 1 inch = 0.25 miles, upon which soil maps, showing soil mapping units, have been superimposed. Although these airphotos are not suitable for stereoscopic viewing, they do show the major drainage pattern of the area including a delineation of floodplain soils and the relative locations of roadways, woodlands, and agricultural areas, in addition to the soil types. Tables are keyed to the soil maps and contain estimated engineering characteristics of the various soil types and an evaluation of their suitability for various engineering usages. Engineering characteristics generally considered in sediment and erosion control design are as follows:

(1) Depth to bedrock

(2) Depth to water table

(3) Unified and AASHO soil classifications

(4) Grain size gradations

(5) Permeability

(6) Available water capacity

(7) Reaction (pH)

(8) Shrink-swell potential

(9) Moisture-density relationship

With regard to the suitability of the soil types for various engineering usages, the following topics are generally covered in the soil survey reports:

(1) Suitability as source of topsoil

(2) Pipelines (construction and maintenance)

(3) Road and highway location

(4) Pond and reservoir sites

(5) Dikes, levees, and embankments

(6) Drainage systems

(7) Irrigation

(8) Terraces and diversions

These soil suitability data are often related to erosion and sediment control considerations.

The state geological survey office is another source of published information for use in making a preliminary site evaluation. In many states water resource bulletins are published for the counties. These bulletins often contain a considerable amount of statistical information on the groundwater characteristics of the various geologic units and on the hydrology of the various drainage basins in the counties.

Where fairly specific subsurface information is desired, the county and state highway departments should not be overlooked. These public agencies often keep on record the results of roadway and structural foundation investigations performed in conjunction with their studies. This is especially true in regard to the more recent highway programs. These results generally include boring and test pit logs, showing soil and bedrock types and groundwater measurements, and the various engineering properties of the soils and bedrock as measured in the laboratory and in the field.

D. Technical Assistance

Technical assistance regarding sediment and erosion control measures is generally available to developers, designers, builders, etc., from several state and local governmental agencies. In most counties this type of technical guidance can be provided by the County Soil and Water Conservation District. Assistance in interpreting the county soil survey report can be provided, and in many cases District personnel are able to inspect the proposed development site.

The office of the State Geological Survey can be contacted for information regarding geology and hydrology and their potential problems. This agency can usually provide general information concerning the site based on the pertinent literature, the geologic and topographic mapping, the statistical records, and personal experience. Where the problem will require a detailed field reconnaissance and possibly a subsurface investigation, a geological consultant should be employed.

In many parts of the nation, the county or city public works departments can also provide technical assistance.

In those states which have enacted erosion and sediment control laws, technical assistance can generally be obtained from conservation specialists employed by the county and state governments.

E. Evaluation of Prime Physical Features

A preliminary site evaluation requires an assessment of the prime physical features which are critical to erosion and sediment control and have aesthetic value. It is important that these features be studied and that they be delineated on a site map for use in evaluating different layout schemes.

1. Land Type

For the purpose of erosion and sediment control planning, the proposed development site should be categorized into three basic land types. They are, in order of potential erosional severity, as follows:

(1) Barren areas

(2) Agricultural areas

(3) Woodland areas

Barren areas (Figure 1) are nearly or totally void of any vegetation. These areas will require considerable grading and elaborate and costly vegetative and structural measures to control erosion and sediment during and after construction.

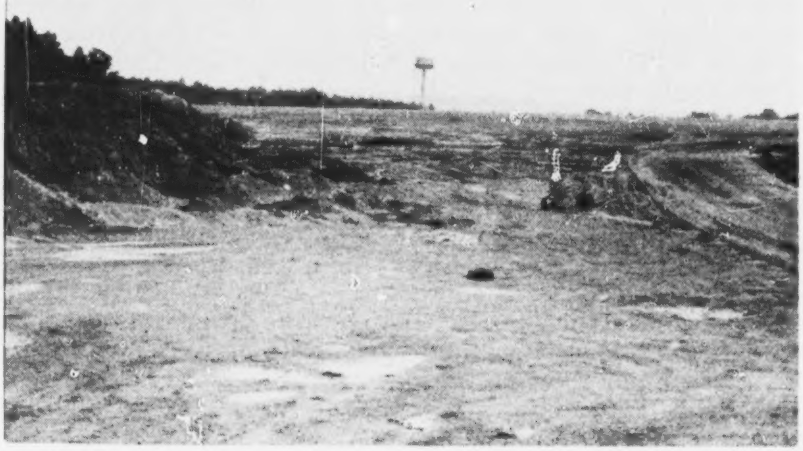

FIGURE 1. Barren area

Agricultural areas (Figure 2) are open areas under cultivation or capable of being cultivated. Unless these areas are planted in grain crops, agricultural areas generally support a stand of grasses, legumes, or herbaceous plants.

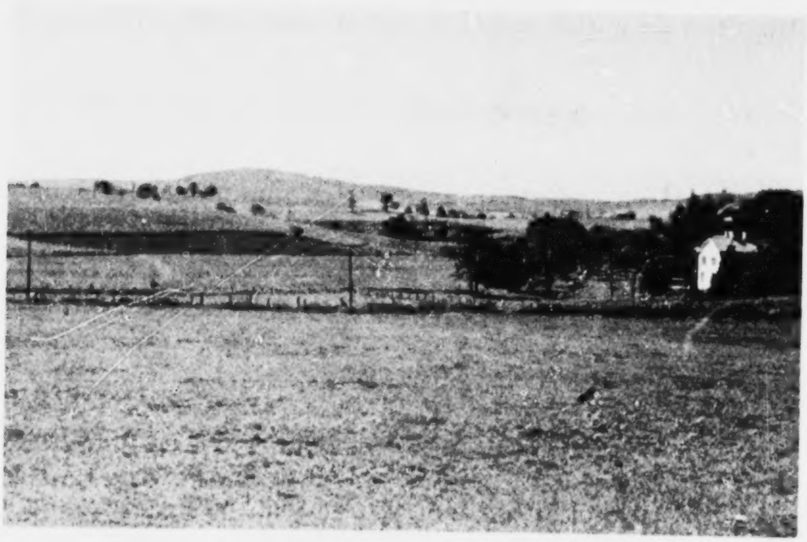

FIGURE 2. Agricultural area

Woodlands (Figure 3) is a self-explanatory term. Woodlands are described as mature stands, pole stands, and mixed stands. Mature stands (Figure 4) generally contain trees with trunk diameters of 10 inches and greater, measured at chest height. Pole stands (Figure 5) are thick stands of tall, small crowned trees with trunk diameters between 6 and 10 inches. Mixed stands (Figure 6) contain both mature sized and pole sized trees. Mixed stands generally occur in woodlands that have been selectively lumbered, whereas pole stands generally occur on tree plantations or in woodland areas that have been previously clear cut or burned over.

Mature trees with full crowns have the highest aesthetic value. However, they are less likely to recover from injury than are smaller and younger trees. Mature trees, due to their crown size, bark structure, trunk strength, and broad root structure, are more able to resist the changes in wind and sun exposure resulting from extensive clearing. Crowded pole sized trees often have constricted crowns and root systems in proportion to their height. This condition reduces their ability to withstand exposure to intense sun and wind.

FIGURE 3. Woodland area

FIGURE 4. Woodland area - mature stand

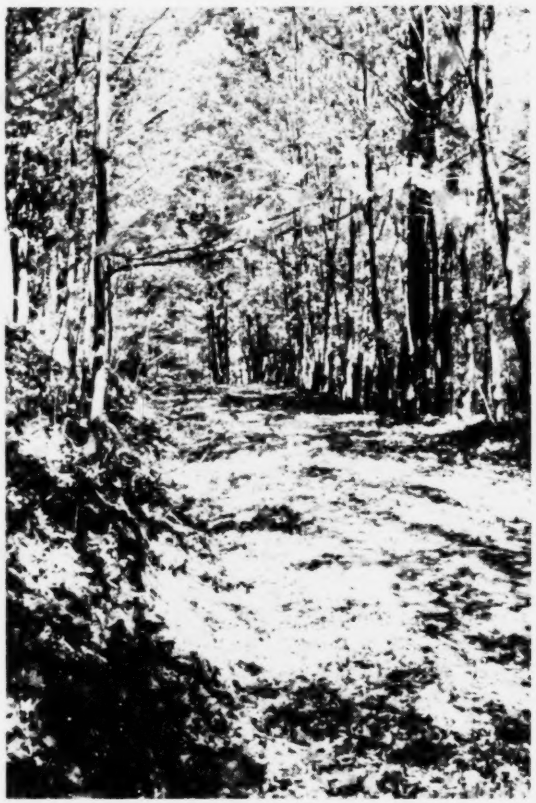

FIGURE 5. Woodland area - pole stand

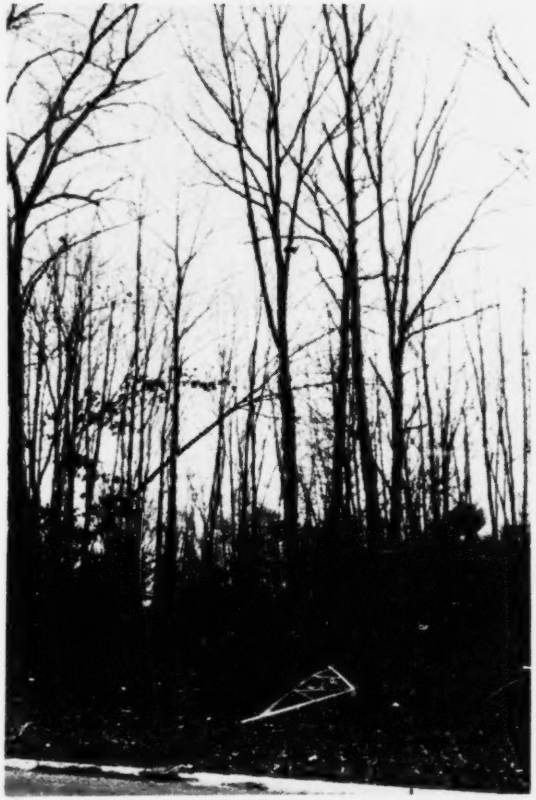

FIGURE 6. Woodland area - mixed stand

2. Soil and Rock

The presence of highly erodible soils is a very critical physical feature. This is especially true if these soils occur on moderate to steep slopes. It is not always possible for the layman to recognize a highly erodible soil horizon. It may be masked by a stand of vegetative cover or it may exist as a soil horizon beneath a surface soil of different character.

Highly erodible soils are usually characterized by a deficiency of soil particles that have cohesive strength. This cohesive strength is usually a function of the clay sized (colloidal) fraction of the soil horizon. However, there is no absolute rule of thumb because soil characteristics can be variable even within the boundaries of individual soil mapping units.

It is very important, however, that the presence of highly erodible soils be confirmed at an early stage of the site survey. Professional assistance should be obtained if there is any doubt. The cost of this professional assistance will be a good investment if the serious problems associated with erodible soils can be ascertained early in the planning phase of any development program.

A knowledge of the occurrence of rock outcrops at a proposed development site is also important in making a preliminary site evaluation. Rock outcrops, when properly positioned within a residential community, have high aesthetic value. They do, however, create difficulties when installing underground utilities and when excavating for road cuts and building foundations.

Where rock will be encountered in excavations, consideration should be given to stockpiling the rock for use in erosion and sediment control structures. Rock has use as riprap and for fill in wire gabions (Appendix B) for prevention of erosion along stream channels and shorelines. Rock is commonly used to protect drainage ditches (Figure 7) where the grade is severe and is also used as an energy dissipator at the outlets of drainage conduits. Some durable rock types also have value as a landscape material.

3. Streams

Streams deserve very careful examination in any preliminary site evaluation. Not only are they the recipient of sediment from the development site and a transporter of sediment to private and public properties downstream from the development, but they can themselves contribute to the sediment load through channel degradation and bank erosion.

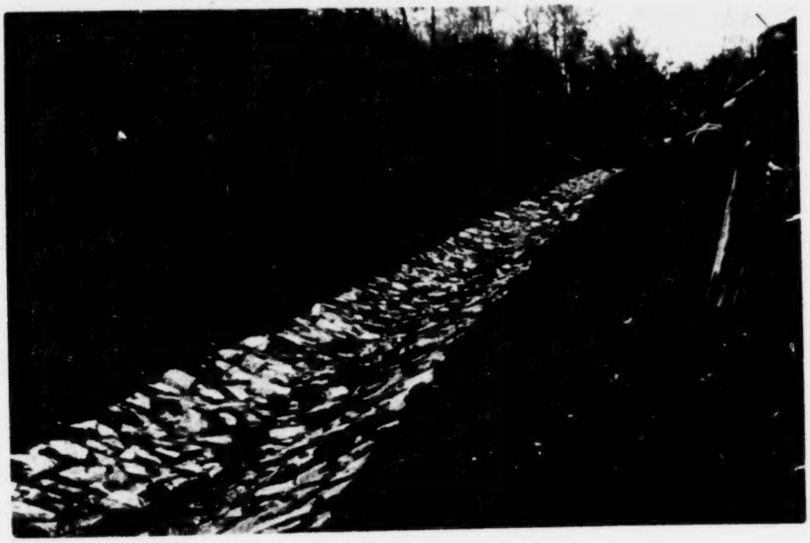

FIGURE 7. Channel lined with hand placed rock

In an urban development, three major factors contribute to increased stream erosion. These are:

(1) Restriction of the stream channel due to sedimentation or construction

(2) Increased runoff due to decreased infiltration in the runoff area

(3) Destruction of the natural vegetation along the stream banks

Channel restriction causes increased flow velocities and these, in turn, are major contributors to erosion and flooding. Decreased infiltration also delivers more water to downstream areas by causing deeper and faster stream flow. These characteristics contribute to the compounding of downstream runoff problems.

If extensive damage due to flooding, erosion, and sedimentation is to be averted, several factors must be considered by the engineer or scientist when evaluating a stream. They are:

a. Size of Stream. For small streams running through large developments, the erosional effect of increased runoff is certainly a major consideration in sediment and erosion control. For large streams or rivers, the effects of the increased runoff and erosion contributed by an urban development along the stream banks is more easily controlled.

b. Stream Gradient. The gradient of the stream will, to a large extent, affect its sediment transport capability. Wide floodplains, meandering courses, and sediment buildup in the channel are indications that the gradient of the channel is shallow and that increased sediment load will cause additional sedimentation of the channel. This condition, in combination with increased runoff due to development of the watershed, could result in flooding during periods of concentrated heavy precipitation.

c. Alignment Configuration. Since streams are one of the most dynamic entities in nature, it should be recognized that room for normal channel migration and adjustment to newly imposed runoff stress must be maintained or provided. Therefore, recreation area construction, i.e., walkways, bridges, etc., must be carefully sited and planned if they are to survive.

d. Bank and Bottom Conditions. Where the stream banks are high and steep, additional runoff from the watershed due to urban development causes serious streambank erosion problems. This problem can be especially severe at bends in the stream where the force of the flowing water is directed against the outside (cutbank) of the bend. Erosion control structures, such as riprap, Fabriform® or gabions (Appendix B), may be required along the outside of the bend in order to prevent erosion.

Every attempt should be made to preserve or enhance the vegetative cover of stream banks, especially grasses, sedges, and woody shrubs with dense fibrous root systems. In poorly vegetated areas along fairly straight stretches of steep stream bank it is necessary to flatten the slopes (generally 3:1 or 4:1, depending on bank height) and establish a good vegetative stand in order to control streambank erosion.

For youthful streams, i.e., those streams where downcutting is in progress, the condition of the stream bottom should be studied to see if the anticipated increase in flow will negatively affect the stream bottom. If serious erosion is anticipated, grade control structures must be constructed along the stream course. These structures are generally check dams (Appendix B) constructed of either wood, concrete, or rock.

4. Floodplains

Floodplains are an integral part of the drainage system of the area, not something apart from the drainageway. During periods of intense runoff they become inundated by flood flow and act as an extension of the stream itself. Therefore, the integrity of the floodplain (Figure 8) must be preserved.

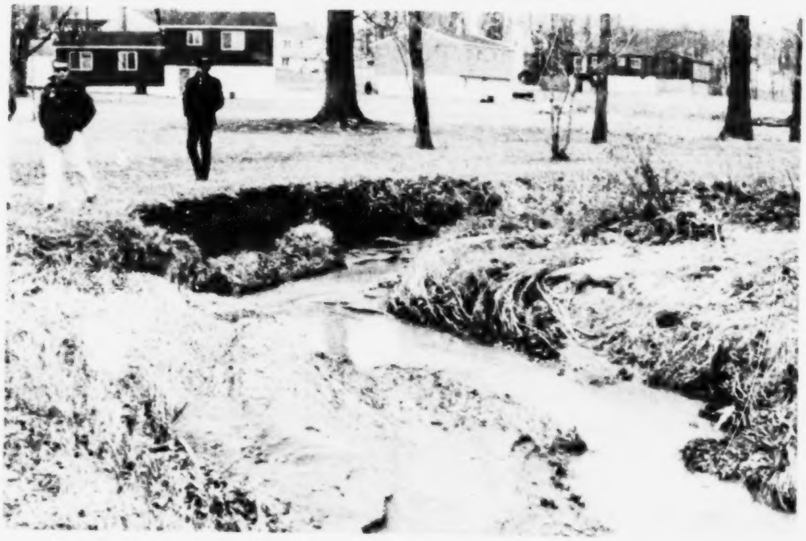

FIGURE 8. Floodplain in developed area

Development on floodplains is wrong, both from the standpoint of protection of life and property during periods of flood flow and from the standpoint of erosion and sediment control. Local building codes and state floodplain regulations should be consulted to determine what legally constitutes an undevelopable floodplain. In applying the requirements of the local building code, the developer should keep in mind that in an urban development, the runoff characteristics will be much more severe during and after development than prior to development. If the undevelopable floodplain is defined in the code as the area flooded by a 100 year storm event, the developer should calculate the limits of the floodplain on the basis of a 100 year storm occurring after the development is complete, rather than before development when runoff is less.

5. Impoundments

With proper planning, man-made ponds, such as farm ponds, can be effectively utilized for stormwater retention and sediment collection during construction. Properly constructed with sufficient area and capacity, it is desirable to preserve such ponds after development for aesthetic and recreational benefits and for runoff control. These practices are encouraged.

Natural impoundments, such as lakes, are aesthetically valuable physical features and should be protected against sediment damage. During the preliminary site evaluation, the existing conditions of the lake and shoreline should be evaluated in order to determine what deleterious effect sedimentation could have on the ecological and physical features of the impoundment.

In evaluating man-made ponds for possible use in stormwater management and sediment collection, it is necessary to determine whether or not the pond is of sufficient capacity to safely handle the required design flow as determined for anticipated conditions occurring during and after development. When the impoundment trap efficiency is severely reduced by sediment buildup, it will be necessary to rejuvenate the pond by removing the sediment. Sediment must be disposed of in a manner which will not permit its reintroduction into the drainage system.

6. Groundwater Conditions

Groundwater conditions are often overlooked in evaluating a possible development site. If not considered, groundwater (Figure 9) can cause very serious construction difficulties that directly and indirectly affect erosion and sediment control. For example, groundwater seepage from roadway cuts prevents the establishment of a good vegetative cover and causes soil to slough into the ditches where it is directly introduced into the drainage system.

The most telling indication of a high groundwater table is the presence of springs. Another indication is mottling in the soil. This mottling reflects a seasonal high water table.

7. Vegetative Cover

A dense vegetative cover of grass, weeds, shrubs, vines, or trees is very effective in preventing erosion on steep slopes, swales, and along drainageways and impounded waters. It is important that the vegetation on a proposed development site be evaluated in terms of its benefit to erosion and sediment control. For example, if steep slopes, which would be subject to severe erosion when denuded, are covered with a good stand of natural vegetation, serious consideration should be given to not disturbing the existing vegetation during proposed development.

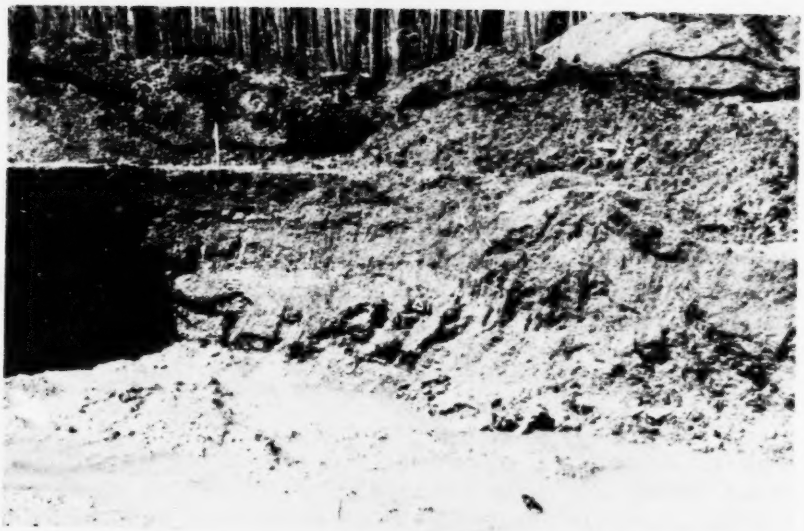

FIGURE 9. Groundwater table exposed in a basement excavation

The vegetative cover along waterways (Figure 10) and around impoundments must be protected, since it serves as a soil stabilizer and as a filter for sediment-laden water flowing into water courses. The most effective natural filters are thick stands of grasses and legumes. However, any vegetation, even if it is weeds, is considerably better than naked earth.

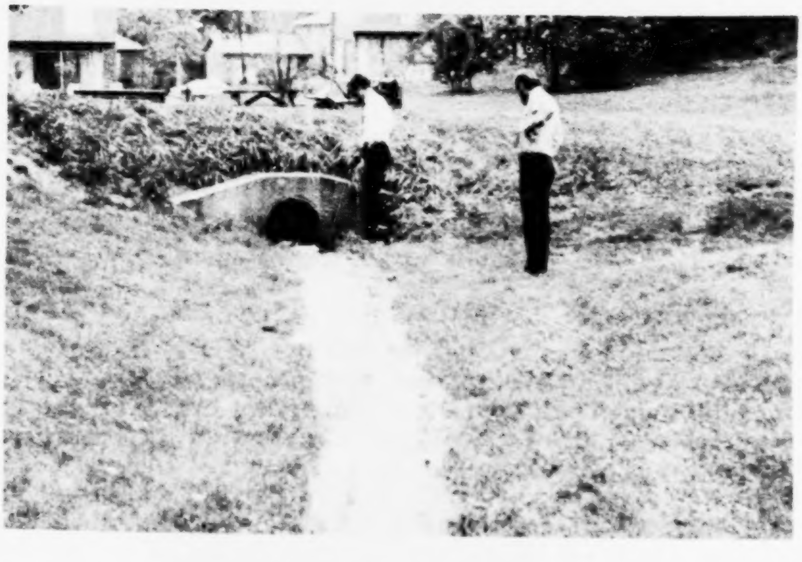

FIGURE 10. Well established vegetation in a minor drainageway

SECTION III

PLANNING

A. General

Planning is the process by which a development and/or construction plan is formulated. For larger developments, the planning process can be broken down into four progressive steps as follows:

(1) preliminary site investigation

(2) preliminary design

(3) subsurface investigations

(4) final design

For small developments, steps (1) through (3) are commonly combined. In each step of the planning process, erosion and sediment control, including stormwater management, should be one of the major considerations. To be successful any plan must also include close scheduling and coordination of construction activities and provision for the maintenance of conservation practices. Stormwater management "detention practices" should be developed to reduce the impact of minor storms which cause accelerated erosion of stream channels and drainageways and should not be confused with control of flood flows.

B. Preliminary Site Investigation

1. Delineation of Critical and Prime Physical Features

During the preliminary site investigation, the critical physical features, as discussed in Section II of this document, must be evaluated in terms of their relationship to erosion and sediment control and their aesthetic value. Those critical physical features which are determined to have a significant influence on erosion and sediment control or which have a high aesthetic value requiring protection should be delineated on a suitable base map of the development site. This procedure involves little extra work if a good preliminary site evaluation has been performed prior to acquisition of the site.

In addition to those critical and aesthetic physical features discussed in Section II, it is also necessary to show the complete drainage system on the topographic map. This must be done in the planning stage. Furthermore, for small woodland developments, it is recommended that the individual prime trees be located on the topographic map. For large woodland tracts, especially those where the topographic map was developed from airphotos (photogrammetric map), it may be impossible to delineate individual prime trees at this time, unless they are of extreme economic and aesthetic value. However, as a minimum, the large woodland tract must be delineated on the basis of major stand types and age classes, as discussed in Section II.

2. Detailed Topographic Mapping

In order to provide enough detail with which to delineate the drainage system and prepare an erosion and sediment control plan that will protect each lot in the development and provide sufficient space on which to record critical physical features, the topographic map should have a scale of 1 inch = 40 or 50 feet and a contour interval of two to five feet. In addition, it is recommended that the topographic mapping be extended a minimum of 100 feet beyond the boundary of the development site in order to assess the affect that erosion and sediment deposition may have on adjacent properties. This extension facilitates the integration of on-site erosion control planning with the surrounding topography.

C. Preliminary Design

During the preliminary design phase, every attempt must be made to site the development in a manner which will minimize damage to those physical features which are critical to erosion and sediment control and those physical features that have high aesthetic value.

Grading damage caused by roadway and home construction should be held to a minimum by avoiding steep slopes which will result in high cuts and fills and by following the natural ground contour as closely as possible.

Extreme care must be exercised in locating drainageways to be sure that the resulting channel gradient and related discharge velocity will not cause erosion of the vegetative drainageway liner. In the event that these limiting factors are exceeded, costly structural measures, such as concrete or stone lining or grade control structures, will be required.

Whenever possible, underground utilities should be located in such a manner that an undisturbed vegetative filter strip (Figure 11) can be preserved between the utility and adjacent drainageways during construction. The location should also allow for stockpiling of excavated soil on the upslope side of the trench (away from the channel).

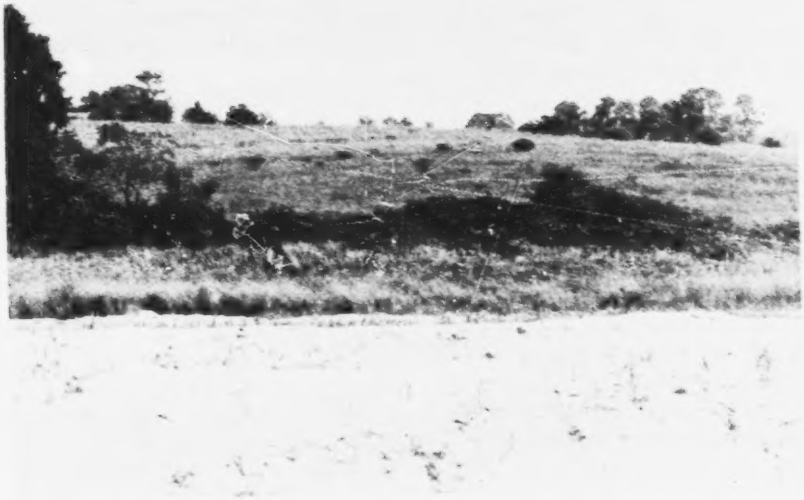

FIGURE 11. Natural filter strip separating bare soil (foreground) from a stream channel (dark vegetation in middleground)

D. Subsurface Investigation

The subsurface investigation must not be limited to those geological features and soil characteristics which are classically related to the fields of soils and geological engineering. It must also be utilized to determine the erodibility of the soils and their capability to sustain a long-term vegetative cover. It is essential that the designer take these factors into consideration in the development of his grading plan.

1. Vegetative Stability

As a general rule of thumb, a 50 percent (2:1) slope is assumed to be the maximum slope upon which vegetation can be satisfactorily established and maintained. However, maximum vegetative stability cannot be attained on slopes steeper than 33 percent (3:1). Optimum vegetative stability requires slopes of 25 percent (4:1) or less. The maximum slope should only be applied to ideal soil conditions where the soil is not highly erodible and has an adequate moisture holding capacity.

For droughty soils (those which exhibit a poor moisture holding capacity due to excessively high permeability and a low percentage of fines) and for highly erodible soils, the maximum permissible slope should be considerably less than 50 percent.

Droughty soils generally have less than 30 percent fines. Where these soils are encountered in cut areas and where reconditioning by the addition of fines or suitable topsoil is not planned, it is strongly recommended that the cut slopes not exceed 33 percent (3:1) in order that a satisfactory vegetative cover can be established. Furthermore, these soils must be planted with warm season, deep rooted, drought resistant grasses and legumes suited to that particular region. For more drought resistant soils with greater than 30 percent fines, conventional cool season grasses and legumes of the region can be utilized.

Where fills are to be constructed with droughty soil and where some finer grained, drought resistant soils are also available, a portion of the drought resistant soil should be segregated for later use in top dressing the fill.

Soils containing excessive amounts of fines, especially clay sized particles such as clays and clayey silts, can also be difficult to stabilize with vegetation. The tight structure of many of these soils inhibits root development and the infiltration of moisture. Cut slopes in these types of soils must be kept as flat as possible in order to enhance infiltration. On flatter slopes where sloughing will not occur, it is recommended that the slopes be top dressed with topsoil or other suitable soil or that the existing soil be reworked by scarification and the addition of organic material and fertilizer. On steep cut slopes, the existing soil should be reworked as the cut progresses and while the slope is accessible to scarification, spreading, and compaction equipment.

Roughening the soil surface enhances the establishment of vegetation on any soil slope. This practice favorably affects germination because it reduces sheet erosion and increases water infiltration. The soil surface should be roughened along the contour in order to reduce the chance of rilling. Although this practice favorably affects the establishment of a vegetative cover, it should not be considered as a substitute for mulching practices (Appendices A, C, and D).

The establishment of locally adaptable ground covers and shrubs assures a long lived vegetative erosion control cover on critical slopes. Therefore, it is often desirable to include seeds of these plants along with the conventional hydroseeding of grasses and legumes. Overplanting grassed slopes with ground covers or shrubs before vegetative deterioration results in slope erosion, or planting directly to ground covers and shrubs using erosion control mattings or mulches (Appendices A, C) to prevent erosion during the period of establishment are also acceptable practices.

2. Soil Erodibility

Soil erodibility is dependent upon several physical features. These include the relative proportions of sand, silt, and clay in the soil; the organic content of the soil; the soil structure; and the permeability of the soil. Knowing these parameters and by using one of several methods available for the computation of gross erosion, a measure of soil erodibility, expressed as tons of removed sediment per acre of surface area, can be determined.

Well graded soils generally exhibit a relatively high resistance to erosion because they have both cohesive and intergranular strength. On the other hand, loose granular soils, especially those which are fine grained, are highly erodible when exposed on steep slopes. Some types of clay soils are less erodible than others because they have greater cohesive strength; however, many of the indurated clays and silty clays that contain expansive clay minerals are susceptible to excessive erosion by slaking and alternate wet and dry cycles.

3. Soil Chemistry

The engineering soil testing program must be expanded to include testing to determine the pH and nutrient level of soils that will be brought to the surface by construction activities since these soils will soon have to support vegetation. In addition, in those regions of the country where toxic soil compounds are commonly encountered, testing must be performed to determine the existence or nonexistence of these compounds so that corrective measures can be taken.

pH problems are common and must always be investigated. Excessively acid soils will require periodic applications of crushed or pulverized limestone, dolomitic limestone, etc., in order to maintain a good vegetative cover. In some cases the use of vegetation with acid tolerant characteristics is possible. The major elements which affect the nutrient level of the soil are nitrogen, potassium, and phosphorus. Soils deficient in these nutrients will require periodic applications of proper fertilizers, selected on the basis of soil tests. Excessive concentrations of certain nutrients can be toxic to the vegetation.

4. Groundwater

Groundwater seepage is caused by the exposure of the groundwater table and can cause serious erosion and sediment control problems. Where subsurface investigations reveal severe high water table conditions, every effort must be made to minimize disturbance of these potential problem areas. The best practice is to avoid disturbance where these conditions exist.

This is especially true with fluid clay formations. On steep cut slopes, seepage can cause severe sloughing in erodible soils. Excessive seepage also prevents the establishment of a satisfactory long term vegetative cover.

Where seepage is encountered in cuts, costly structural measures will often be required in order to reduce or eliminate the erosional problem. Where the seepage is confined to a small localized area, the water can generally be trapped below the surface by using perforated drain pipe and graded stone and sand filters. It must then be lead safely downslope to a satisfactory disposal area. Where the seepage extends for a considerable distance along a slope and where the slope is accessible to construction equipment, a longitudinal pipe and stone underdrain will be required. On steep slopes, inaccessible to construction equipment, it will be necessary to surface the slope with filter cloth (Appendix C) and crushed stone or other suitable materials.

5. Topsoil

To be satisfactory, a topsoil must contain at least 30 percent fines (material passing the 200 sieve) and should conform to the state standards for organic content, weed seed content, and noxious weed content. Contrary to popular belief, the quality of some topsoils does not justify their salvage and stockpiling for later use as top dressing on graded slopes. If topsoil quality is substandard, it will be necessary to establish vegetation by adding required nutrients, chemicals, etc., directly to the exposed soil surface. A satisfactory seedbed can be attained by working these materials into the upper four inches of the soil by mechanical means. Nutrient and chemical additive quantities must be established on the basis of soil test results, not guesses.

E. Final Design

1. Stabilization of Major Waterways

Major waterways include all natural or constructed waterways which can be classified as either permanent or intermittent streams.

The individual or combined effects of increased runoff, channel constriction either caused by siltation or construction, and destruction of natural vegetation greatly accelerate waterway erosion. All of these conditions commonly occur with urban development. Some of these effects can be totally avoided or minimized through good site planning.

On large developments, the erosive effect of increased runoff can be minimized through stormwater management. This often requires the construction of storage ponds in critical areas of the watershed which will provide for the collection and storage of runoff during periods of of heavy precipitation. The ponds should be constructed to allow the gradual release of the stored runoff during low flow periods. Storage ponds also favorably affect infiltration and evaporation, both of which reduce the total runoff. They also collect sediment which would otherwise be deposited in the waterways or other downstream sites.

Filling of floodplains must be avoided, except at roadway crossings. Where crossings are made, the conduits must be adequately sized, keeping in mind that the runoff will be much greater after construction has been completed. Conduits must be placed so that erosion of the stream banks and channel will not be accelerated in downstream areas. Above all, the natural vegetation, whether it be grasses, brush, or trees, along and adjacent to natural waterways must be protected from construction activities and preserved in its natural condition.

Vegetation along waterways is beneficial to erosion and sediment control in three important ways. First, the dense rootmat helps hold the soil in place. Secondly, the foliage, in the case of grasses, legumes, and other low growing plants and dead litter, such as leaves, filters out sediment from the overland flow. Vegetation also dissipates the erosive energy from falling raindrops, a most important contribution to sediment and erosion control.

In the event that the above mentioned practices cannot achieve satisfactory erosion control, induced vegetative and structural practices will be required to control the problem.

Vegetative measures (Figure 12) are both practical and economical in many cases where one or more of the following conditions exist:

(a) Poor quality vegetative cover

(b) Relatively flat terrain

(c) Low stream banks

(d) Tangential flow

(e) Low flow velocity

(f) Fertile soil

Prior to planting the vegetation, the banks will have to be graded back on a fairly flat slope, preferably 25 to 33 percent or flatter. Although excavation will destroy any existing vegetation on the bank, it is preferred over filling, since excavation increases the capacity of the channel rather than constricting it. Excavation is less likely to cause severe sediment pollution problems. With regard to the control of sediment pollution from stream bank modification, it is also desirable that the grading be performed during periods of low precipitation and that the work be staged so as to minimize the time of soil exposure.

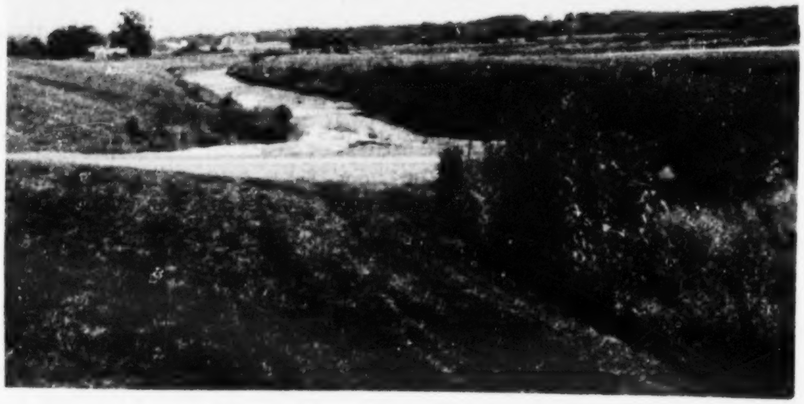

FIGURE 12. Vegetative streambank stabilization

Vegetation for use in stream bank stabilization should be selected on the basis of its tolerance to the following factors:

(a) Erosive forces

(b) Soil moisture

(c) Sedimentation

(d) Soil conditions

In most cases, it is desirable to use strip planting techniques. This involves the planting of a strip of wet soil tolerant, highly erosion resistant vegetation in the critical area near the water line, and the planting of conventional robust rooted grasses and legumes above the critical zone. For added protection in selected locations, wet soil tolerant bushes and trees can be planted near the water line. In order to protect the graded and planted areas until a strong stand of vegetation is established, it is recommended that an erosion control netting or blanket (Appendix C) be utilized in addition to normal mulching practices.

Assistance in selecting local types of vegetation for use in waterway stabilization is available from the local soil and water conservation district, the state forest services, fish and wildlife agencies, and others.

Vegetative measures alone may not be able to resist the erosive forces at obstructions and bends in the streams. In these cases, channel maintenance or structural measures (Appendix B) will be required.

Indiscriminate removal of obstructions such as logs or boulders should not be encouraged since they are required by fish and other aquatic life. These obstacles, whether they be debris or bends in the channel, are natural energy dissipators, and their removal increases the velocity of flow and thereby intensifies erosion at critical areas further downstream. Straightening is also undesirable since it steepens the stream gradient. Steepened gradient increases the rate of downcutting in the channel or it may rejuvenate the downcutting cycle in a stable channel. Headwater gully erosion is also encouraged. The removal of recently deposited sediment from the stream channel is beneficial, since it returns the stream to a more stable and more natural alignment and channel configuration.

Structural measures for protection of natural waterways against erosion fall into two types. The first type of structure is known as a grade control structure while the second type is commonly called a bank protection structure. Grade control structures are utilized to control the gradient of the waterway channel in a manner that will reduce the velocity of flow and thereby minimize both channel and bank erosion.

The most common grade control structure is the check dam (Figures 13, 14, and 15). Check dams are short dams constructed of a wide variety of materials including logs, treated lumber, stone, concrete, and synthetic materials which flatten the slope of the stream and dissipate energy. Stone or concrete should be placed in the high energy area at the downstream toe of the check dam in order to prevent undercutting of the structure. Check dams should be used with caution on streams which are susceptible to flooding, since they reduce flow rates and thus increase the chance of flooding.

There are two types of bank protection structures; revetments, and deflectors. Revetments comprise a wide variety of both rigid and flexible structures which are used as an erosion resistant facing on stream banks and lake shores. The flexible type of structure is by far the most desirable and is generally more economical for stream bank protection. Flexible revetments, such as riprap, Fabriform® mats, gabions (Appendix B), etc., have an advantage over rigid revetments, such as asphalt paving or monolithic concrete, because they are able to adjust to minor changes in foundation conditions without losing their integrity. The most flexible and the most common revetment type used for stream bank protection is randomly placed stone riprap. It is composed of loose stone placed on a sand/gravel filter and/or filter cloth. Other types of flexible revetments, although not nearly as flexible as stone riprap, are gabions (Appendix B), Fabriform® mats (Appendix B), interlocking concrete blocks, and steel or concrete tetrahedrons.

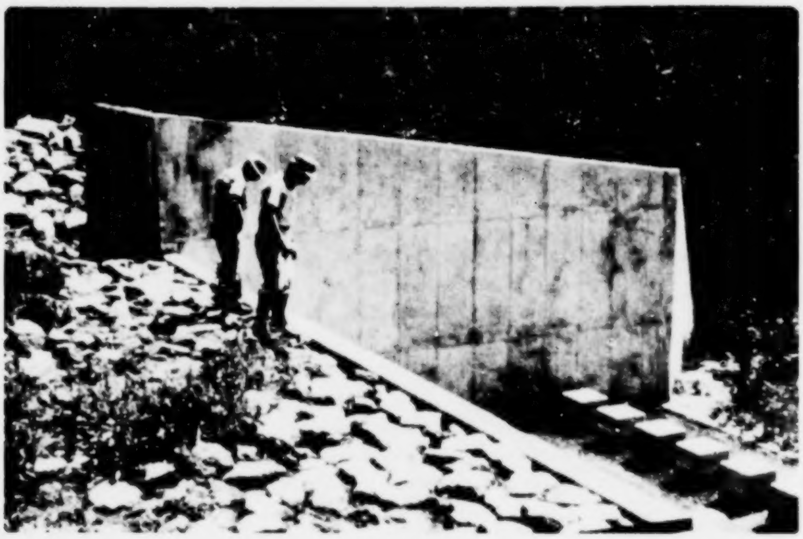

FIGURE 13. Check dam with energy dissipator

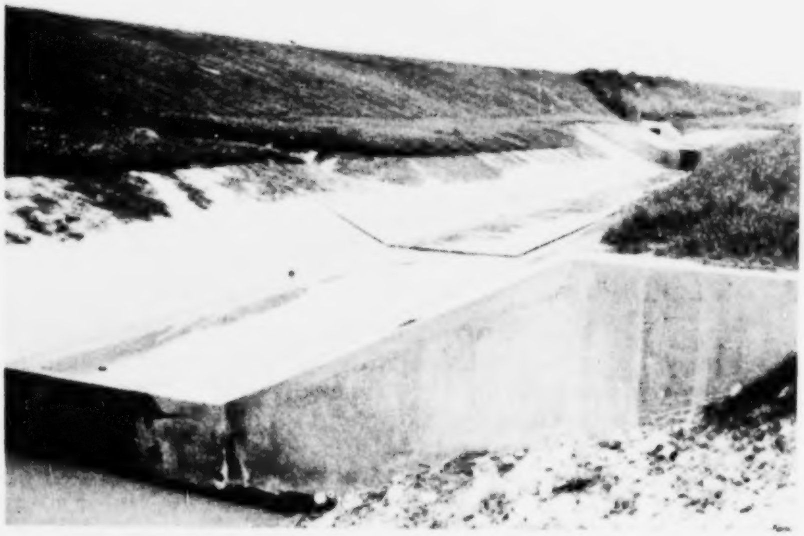

FIGURE 14. Combination of check dams and lined channel

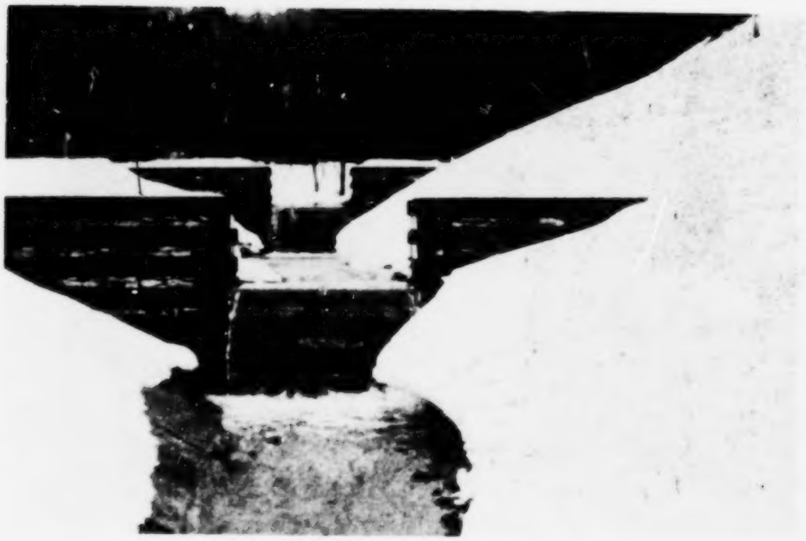

FIGURE 15. Check dams (weirs) constructed of wood

The type of revetment selected for a particular bank condition will depend upon the strength requirements, the cost, length of required service, and aesthetic factors. In areas not requiring the extreme durability of randomly placed stone riprap, or in areas where rock is not readily available, other types of revetments may, for economic, fish and wildlife habitat, or aesthetic reasons, be more desirable.

Common types of rigid to slightly flexible revetments include concrete or asphalt paving, grouted stone riprap, and sacked concrete (Figure 16). To be effective, a rigid type revetment requires a firm, stable foundation and careful construction. Where fills are being protected, a high degree of compaction is required beneath the revetment to prevent excessive settlement. To prevent undercutting at the toe, all revetments should be carried several feet or more, depending on the design analysis, below the existing ground surface. For rigid and for some partially flexible types of revetments, an extra margin of safety against undercutting is commonly achieved by placing adequately sized loose stones at the toe of the revetment. When properly constructed and maintained, rigid types of revetment can perform adequately as erosion control structures. They can therefore be considered when selecting and designing a bank protection revetment if other flexible types cannot be utilized.

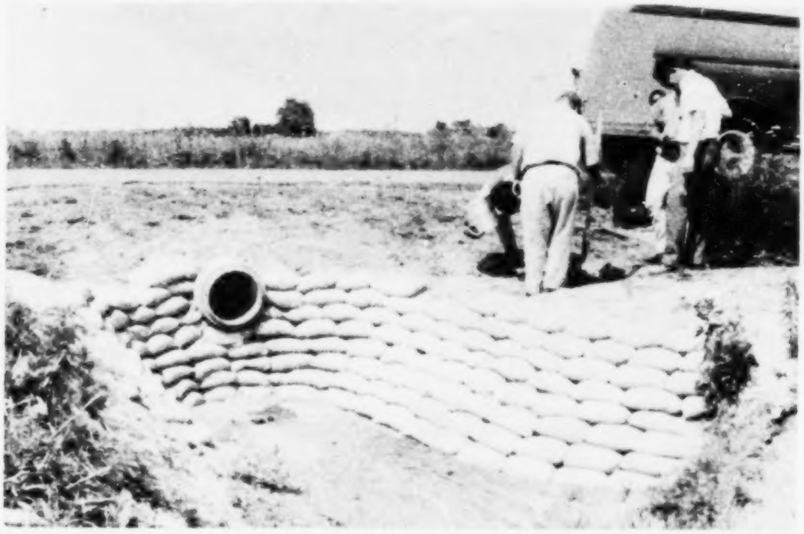

FIGURE 16. Sacked concrete revetment

All flexible and most rigid revetments are placed on a grade of approximately 50 percent (2:1). Several types of rigid revetment, including some varieties of gabions, wood sheet piling, and metal sheet piling, are constructed with a vertical face. These types of revetments are commonly used where water access, such as for boat traffic, is essential. The vertical types of revetment are also used as retaining walls in situations involving the filling of floodplains. From the standpoint of erosion and sediment control and stormwater management, such reclamation work is undesirable, since it constricts the channel and thereby increases the likelihood of erosion downstream of the construction area. It also increases the chance of flooding upstream from the constriction.

The other form of bank protection structure, the deflection structure, usually consists of a stone, concrete, or wooden groin which angles outward from the shore in a downstream direction and deflects the current away from a critical area of the stream bank. This type of structure should only be used in large streams where the deflected current will not jeopardize the opposite stream bank. In constructing a groin-type deflector, it is extremely important that the foundation be protected on both the upstream and downstream sides against scour damage. This is generally accomplished by placing the foundation below the anticipated scour depth and by placing a flexible armor blanket of durable, properly sized stone or concrete fragments along the upstream and downstream edges. This protection must also be provided up the stream bank to an elevation that is above maximum high water flow.

Advice in selecting the type of revetment suitable for a given condition can be normally obtained from the following public agencies:

(a) United States Army Corps of Engineers

(b) United States Bureau of Reclamation

(c) United States Forest Service

(d) Soil Conservation Service (district and state offices)

(e) State geological survey

(f) State department of natural resources (water resources section)

(g) State highway department

(h) County engineering department

(i) Universities

Many types of materials, covering a wide range of costs, are marketed for use in constructing bank and shore protection structures. A selection of the material best suited for a given condition should depend on an analysis of the following factors:

(a) The ability of the material to stand up to the stress conditions occurring on-site

(b) The initial cost and availability of construction material

(c) Maintenance cost

(d) Service life as determined for the conditions occurring at the site

(e) Aesthetic considerations

(f) Replacement cost

A good engineering and economic evaluation requires mathematical and empirical analysis, a knowledge of the available products and their serviceability, and the ability to accurately assess the site conditions. When the planner is not experienced in these matters, a qualified consultant who is skilled in erosion and sediment control work must be retained.

The following publications are also available for reference in designing bank and shore protection structures:

(a) U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, "Use of Riprap for Bank Protection," Hydraulic Engineering Circular No. 11, June 1967.

(b) State of California, Department of Public Works, Division of Highways, "Bank and Shore Protection in California Highway Practice," November 1970.

2. Stabilization of Minor Waterways

Minor waterways include all natural and constructed waterways, such as roadway draining ditches, drainage swales, or diversion ditches, which do not fall under the category of either permanent or intermittent streams.

a. Location of Minor Waterways. The location and design of minor waterways are of considerable importance to a good program of erosion and sediment control. The waterways which collect and transport the surface runoff to the streams in the watershed are one of the major sources of sediment pollution, both during the construction phase and long after construction is complete, if they have been improperly designed, poorly constructed, or inadequately maintained.

Whenever possible, the planner should preserve the natural drainage system. When natural waterways are utilized, care should be taken to preserve the natural vegetation during the construction phase. Traffic must not be allowed in the waterway. It should be realized, however, that the natural vegetation may not, by itself, be able to resist the additional erosive force contributed by increased runoff from the developing or developed area. When this occurs, it will be necessary to reinforce the natural vegetation with additional planting or to resort to structural measures when vegetative practices will not suffice.

b. Construction of Vegetated Waterways versus Lined Waterways. The utilization of vegetated waterways, rather than concrete or asphalt lined waterways, is desirable from the standpoint of stormwater management. The vegetated waterway maximizes the loss of surface runoff through infiltration, whereas the lined waterway allows no infiltration to occur. For the same reasons, it is more desirable, when physical conditions are too severe for the satisfactory establishment of a vegetative cover, to resort to the use of a series of short check dams or to a stone lining rather than to use an impermeable concrete or asphalt lining.

Factors which limit the use of vegetated waterways include excessive soil erodibility, excessive slope, high water table (either normal or perched), excessively droughty soils, and in remote cases, excessive soil toxicity. Without resorting to severe and costly structural measures, such as concrete, asphalt, or stone linings, the problems of excessive soil erodibility and excessive slope can be successfully handled in many cases by using a series of check dams to flatten the gradient of the waterway and to dissipate flow energy.

The problem of wet soil conditions due to a high water table can often be resolved by using pipe underdrains. When excessively droughty or toxic soil conditions are encountered, the problem can be corrected by undercutting and backfilling or top dressing with nontoxic, drought resistant soil. When this procedure is undertaken, care should be taken to get a good bond between the native soil and the placed soil and also to sufficiently compact the placed soil.

c. Design of Grassed Waterways. Robust rooted grasses that germinate quickly and grow rapidly are generally the best type of vegetation for waterway stabilization. When properly maintained, they form a dense rootmat and a dense uniform surface cover that does not restrict the movement of water and benefits both surface water infiltration and the transpiration loss of near surface groundwater. To determine what types of grasses are most suitable for a given locality and a given site condition, the local soil and water conservation district, county agricultural agent, or university extension service should be consulted.

In order to protect against channel erosion in grassed waterways, consideration must be given to the following factors:

(1) The erodibility of the soil for the proposed slope

(2) The flow velocity limitation for the vegetation selected

(3) The ability of the soil to support the selected vegetation

(4) The flow resistance (vegetative retardance) of the selected vegetation

(5) The method of vegetation establishment (sod versus seed) required to accomodate the volume and velocity of the design flow

In general, seeding is only performed in waterways where the design flow velocity is four feet per second or less. Sodding is generally performed in waterways when the design flow velocity is between four and seven feet per second or when seasonal considerations rule out the use of seeding. The velocity requirements indicated above are only for erosion resistant soils. If the soil is erodible at these velocities, then structural measures will be required in conjunction with the seeding or sodding.

d. Stabilization Measures for Grassed Waterways. Temporary stabilization measures are required in seeded waterways and, in many instances, in sodded waterways to protect against erosion until the vegetation is firmly established.

One of the products in common use for temporary waterway stabilization is jute netting (Appendix C). The jute netting (Figure 17) is generally placed directly over the prepared seedbed and, when properly anchored, minimizes soil erosion. Due to its thick, fibrous composition, the jute also functions as a mulch.

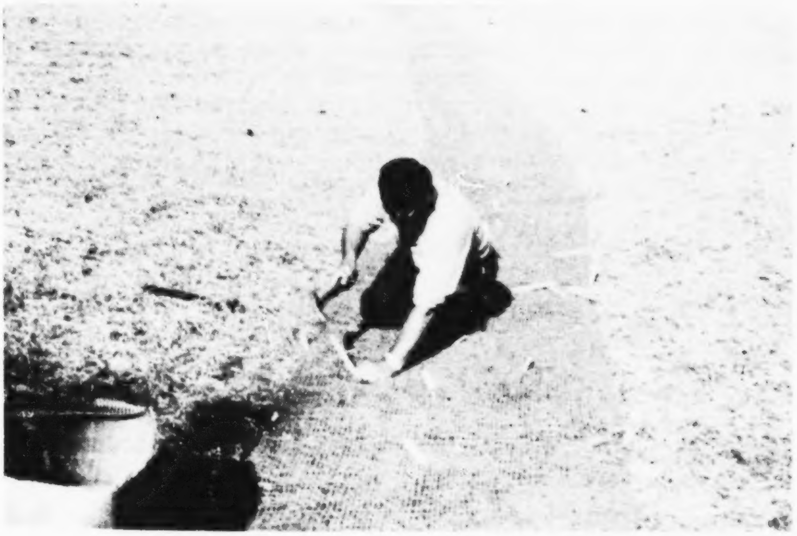

FIGURE 17. Jute netting being used in waterway stabilization

Several other types of erosion control nettings designed for use in waterway stabilization are available on the market. They include plastic, paper, and fiber glass nettings (Appendix C). Both the plastic and the fiber glass nettings, have a longer service life than jute netting; however, due to the dense structure of the individual material strands used in forming the nettings, they do not function as a mulch. Therefore, plastic and fiber glass nettings are used over a long fiber mulch such as straw or hay. They are applied, however, in a similar manner to jute netting.

A common problem in the establishment of vegetation in waterways using nettings and mulch is subsurface drainage, which in permeable, granular soils often causes piping and subsequent loss of soil from beneath the mulch and netting. To prevent such an occurrence, erosion checks (Appendix B) must be established across the waterway and beneath the netting at various intervals along the channel.

For the temporary stabilization of sodded waterways where the soil is granular and moderately to excessively permeable and the design flow velocity is in excess of four feet per second, use of plastic or fiber glass netting and erosion checks in addition to the normal stakedown procedure is recommended.

3. Stabilization of Soil Slopes

Soil slopes include all denuded cut, fill, or natural soil slopes.

a. Slope Design Criteria. Man-made cut and fill slopes are usually constructed with a grade of 0 to 50 percent (2:1). In some instances, when soil and hydrological conditions are exceptionally good, the grade is extended up to approximately 67 percent (1-1/2:1). For all practical purposes, however, vegetative and soil stability factors and maintenance considerations rule out the use of a grade steeper than 50 percent.

A 33 percent slope is considered to be the maximum slope upon which maintenance equipment can reasonably operate.

Factors to be considered in selecting a grade for a particular geologic condition include:

(1) Slope stability

(2) Soil erodibility

(3) Ability of soil to support vegetation

Slope stability falls within the realm of soil mechanics and involves an analysis of a given slope condition to determine whether or not land sliding will occur.

Soil erodibility is a function of the following factors:

(1) The quality of the vegetative cover

(2) The soil gradation and permeability

(3) The degree of soil compaction

(4) Clay minerology (in the case of clayey soils)

(5) The grade of the slope

(6) The length of the slope

(7) The quantity of water collected by the slope

The erodibility of a slope increases as the length of slope increases and also as the quantity of water collected by the slope increases. The effect of these factors on soil erosion can be controlled with the use of various types of diversions (Figure 18) such as terraces, benches, top of cut ditches, temporary diversion dikes, and interceptor dikes (Appendix B). Benches and terraces are used to break the length of cut and fill slopes and to collect runoff and carry it to a safe disposal point.

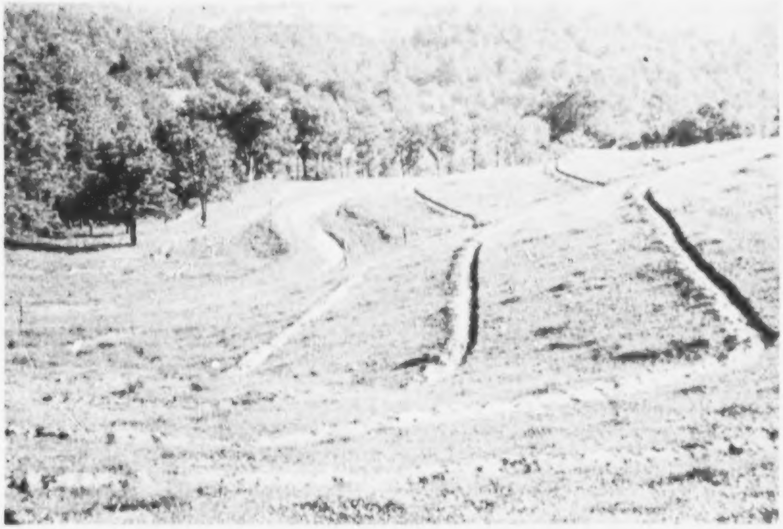

FIGURE 18. Diversions being used to control downslope runoff

Diversion dikes are temporary berms of soil placed along the top of cuts and fills or at intervals along graded natural slopes for the purpose of diverting runoff away from the denuded slope. The runoff is instead diverted to a stabilized disposal point, such as a level spreader, temporary flexible downdrain, temporary sectional downdrain, or chutes and flumes (Appendix B). Diversion dikes are utilized during the construction phase and, in the case of fills, they are generally maintained until an adequate vegetative cover is established. For cuts, the diversion dikes are commonly replaced by top of cut diversion ditches.

Interceptor dikes (Appendix B) are constructed of well compacted soil or crushed rock (filter berm) and are generally used along graded rights-of-way.

Compaction of fills is a major factor in erosion control. Poor compaction is an especially serious problem on small construction projects in urban developments where compaction control is often lacking.

To prevent this occurrence, the planner and the local construction codes should specify the degree of compaction to be achieved on all types of fills. Certainly it is not necessary to achieve 95 percent compaction in fills which will not be supporting structural loads or where some settlement will not affect adjacent structures. However, as a minimum criterion for erosion and sediment control, the upper one foot of all fills should be compacted to at least 85 percent of optimum.

Smoothly graded cut and fill slopes are attractive to the eye, but they are not beneficial from the standpoints of erosion and sediment control and the establishment of a vegetation cover. It is more desirable to roughen the surface, since this procedure slows down flow velocity and enhances water infiltration. To accomplish these effects, the texture of the roughened surface should trend perpendicular to the flow direction. Discing and light scarification (Appendix D) will accomplish this effect. Where the slope is too steep to allow vehicular traffic to travel parallel to the slope, cleated dozers travelling up and down the slope can produce a satisfactory texture on newly placed soil.

The gradation of the soil on the surface of a slope and the permeability of this soil affect both the erodibility of the soil and its ability to support vegetation. For example, many well-drained silty sands are highly erodible and may be droughty. When the soil exhibits either or both of these conditions, it will be necessary to adjust the configuration of the slope to accomodate these factors or to top dress the slope with an erosion and drought resistant soil. As an alternate to top dressing, a suitable soil can be mixed with the existing soil.

On all slopes where top dressing with suitable topsoil or other soil occurs, it is essential that the dressing soil be firmly bonded to the existing soil surface in order to prevent slippage downslope. This bonding can be increased by scarification (Appendix D) of the slope.

The quality of the vegetative cover is not only a function of the physically related characteristics of the soil, such as density, permeability, and moisture holding capacity, but it is also a function of the chemistry of the soil. The pH of the soil, the presence of nutrients in the soil, and the presence of toxic elements in the soil all affect the quality of the vegetative cover.

When the pH and nutrient levels of the soil are known, it is often possible to adjust these conditions to their optimum value for the vegetation to be utilized by the addition of lime, fertilizers, etc. When vegetative conditions occur that cannot be modified, the slope should be top dressed with a more suitable soil.

Seasonal factors also affect the quality of vegetation. Cool, moist periods of the year, such as occur in the spring and fall in temperate regions, are more favorable for seed germination and plant growth than are the hot, dry summer months.

Different types of vegetation vary widely in their ability to tolerate certain climatic conditions. To determine the best vegetation for a climatic condition in a given region, the developer can receive guidance from the local soil and water conservation district, the county agent, or university extension service.

In many parts of the country, quick growing annuals are planted as temporary ground cover until climatic conditions are favorable for the germination and growth of more desirable perennial grasses and legumes.

b. Soil Stabilization Measures. Soil stabilization measures include both short-term measures and long-term vegetative measures and are utilized to control water and wind erosion during and after grading operations.

Interim stabilization measures are used to retard erosion for a short time period, such as over the winter months or through the hot summer months, or until conditions are more favorable for long-term vegetative stabilization. They include practices such as mulching (Appendices A, C, and D) or the use of nettings, blankets, etc. (Appendix C) with the seeding of annual grasses.

In addition to functioning as a short-term stabilization measure, mulches, when applied during permanent seeding, also serve to enhance the germination process by conserving moisture and to dissipate the energy of falling raindrops.

Fiber mulches such as straw, hay, and woodchips (Appendix C), as well as chemical soil binders (Appendix A), are commonly used to stabilize graded areas prior to seeding to permanent vegetation. The chemical soil binders (Appendix A) are designed to penetrate and bind the near surface soil or to bind the surface of the soil. Chemical soil binders are used primarily to protect denuded soil from wind and water erosion during delays in grading operations and also during hot and dry periods, after final grading, or until permanent seeding is possible.

Some chemical soil binders (Appendix A) also function as mulches, i.e., they benefit the germination and growth of seeded vegetation by conserving moisture in the soil and by providing temporary protection against erosion.

In addition to the organic fiber mulches previously mentioned, a fiber glass mulch (Appendix C) is also marketed for use in establishing vegetative cover.

The use of woodchips (Appendix C) for short term soil stabilization and as a mulch is gaining greater prominence with the advent of more restrictive burning and other disposal ordinances and as bigger woodchippers are being built. Woodchips are found to be one of the better mulches. They are long lasting and, due to their weight and shape, they require little or no tacking to keep them in place.

The use of large woodchippers for the disposal of all wood waste, including all tree stems not salvageable for lumber, has considerable merit both from the standpoint of economics and erosion and sediment control. The woodchips produced by the chippers can be used for short-term stabilization and mulch on graded surfaces and as a mulch for ground covers and woody plants. Any excess woodchips can be placed as a four-inch-thick blanket in remaining woodland areas where the natural leaf mulch has been disturbed by construction activity.

With the exception of Glassroot® fiber glass mulch (Appendix C) and, in some instances, woodchips, all organic and inorganic fiber mulches require some form of attachment in order to prevent them from being blown or washed away. Three methods are commonly used to secure fiber mulches. The first method, crimping, is used on straw and hay mulches and is performed by a crimping machine which partially punches the mulch into the soil. The machine operates and looks similar to a standard disc, except that the disc blades on the mulch crimper are notched.

The second method of securing mulches is by tacking. This consists of the application of an asphalt or chemical binder (Appendix A) to the mulch (Figure 19) which binds the individual fibers together to form a resistant blanket. Two types of asphalt products are commonly used. They include liquid asphalt (R.C. 1, 2 or M.C. 2 and 3) which can be applied in freezing weather and emulsified asphalt (R.S. 1 and 2, M.S. 2, or S.S. 1) which cannot be applied in freezing weather.

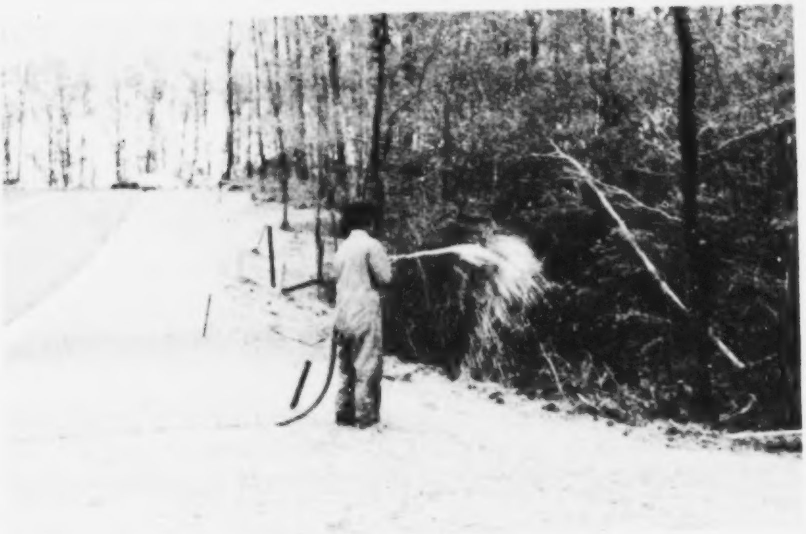

FIGURE 19. Chemical mulch tack being applied

Rapid setting (R.S.) asphalt tacks are formulated for curing in approximately 24 hours even during periods of high humidity. Medium setting (M.S.) asphalt tacks are formulated for use in spring and fall with approximately 24 hours curing time. Slow setting (S.S.) asphalt tacks are formulated for use during hot, dry weather and require approximately 24 hours curing time.

Chemical mulch tacks cure more rapidly than asphalt tacks. This makes them particularly valuable around home construction where tracking of asphalt tack would be a problem.

The third method of securing fiber mulches is through the use of various nettings (Appendix C). Nettings used for this purpose are constructed of jute, plastic, paper, and fiber glass. Jute and paper nettings have a short life span and are biodegradable (Appendix C).

Nettings are normally only used on steep, exposed slopes where crimping is not possible and where tacking will not perform satisfactorily.

Several "blanket" type materials (Appendix C) are available for use where natural or synthetic fiber mulches are not selected. These "mulch blankets" are most often used in establishing vegetation on swales, ditches, and steep slopes when it is decided that the fiber mulch products do not provide sufficient levels of protection during germination and early growth.

c. Sediment Retention Structures. Sediment retention structures (Appendix B) are designed to remove sediment from runoff water. The basic function of these structures is to still the runoff water to such an extent that the sediment has time to settle out of suspension.

The most functional and desirable retention structure is the sediment basin or pond which is installed along a natural or man-made waterway. Sediment basins are normally thought of as short term structures, however, the larger basins may be utilized for recreation purposes after development construction has been completed. The size of a sediment basin is dependent upon the area of its watershed, the topography of the watershed, the infiltration rate of the soils in the watershed, and regional hydrological factors.

Most states have ordinances covering the design and construction of all sizes of sediment basins. These ordinances must be reviewed prior to designing the impoundment.

In almost all cases, the sediment basin is formed by an earthen dam constructed across the waterway. In some cases, however, the impoundment is formed by excavating a depression in the waterway. This practice is generally utilized on small drainage swales and around storm drain inlets during grading operations.

Other types of materials used in sediment retention structures include straw bales, filter berms (Figure 20), and sandbags (Appendix B). These materials are normally used on small jobs where the runoff is small. On sloping lots, straw bales are often used to divert sediment-laden runoff to sediment retention structures.

Crushed stone and sandbags (Appendix B) are often placed around storm drain inlets to filter out sediment. Straw bales (Appendix B) can also be used for this purpose, but care should be taken to keep them from breaking apart and getting into the storm drain system.

Vegetative filter strips (Appendix D) are also used around storm drain inlets to retard flow and filter out the sediment. Thick growing, sturdy grasses should be used for this purpose.

F. Formulation of Erosion and Sediment Control Plan

In order to insure that the erosion and sediment control procedures developed by the planner are implemented by the contractor, it is required that a detailed erosion and sediment control plan be drawn up and included with the other construction documents. The plan must be presented for

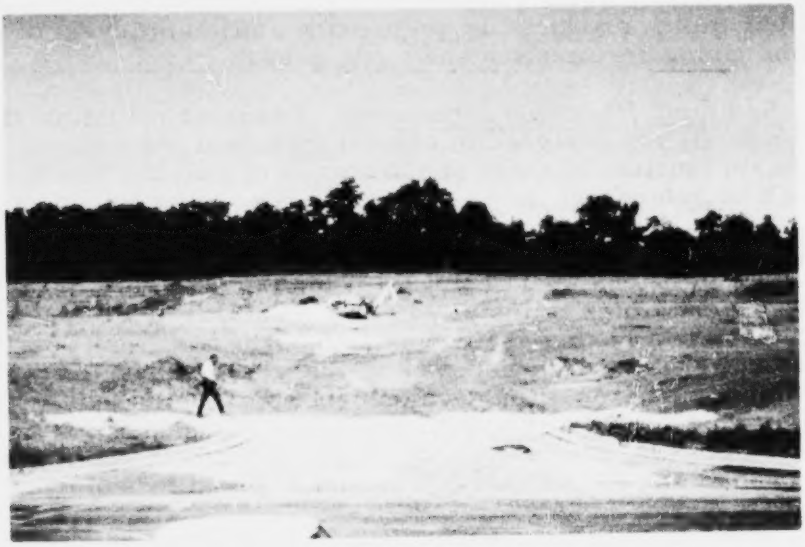

FIGURE 20. Filter berm

review, approval, and certification to all cognizant agencies empowered by sediment and erosion control legislation. A copy of the plan must be continuously available on the job site. Figure 21 is an example of the type of plan that is presently being prepared and used. The size of the project, the intensity of the proposed development, and the land type will, of course, influence the required complexity of the plan, but as a minimum the following factors should be given consideration and included in the documents.

1. Clearing and Grading Schedule

It is necessary that the contractor minimize the amount of land to be exposed at any one time. This can be accomplished by developing the site in stages and by requiring the performance of all clearing, grading, and stabilization operations in a specified area before moving on to another specified area. This procedure should be written into the construction specifications and contract. Maps should be provided which define each area. The sequence and scheduling in which development will occur must be well established and understood by all persons involved with the development operation.

For ease of sediment control, it is usually desirable to define these areas on the basis of watersheds or subwatersheds. The size of the area should be determined on the basis of the construction capability

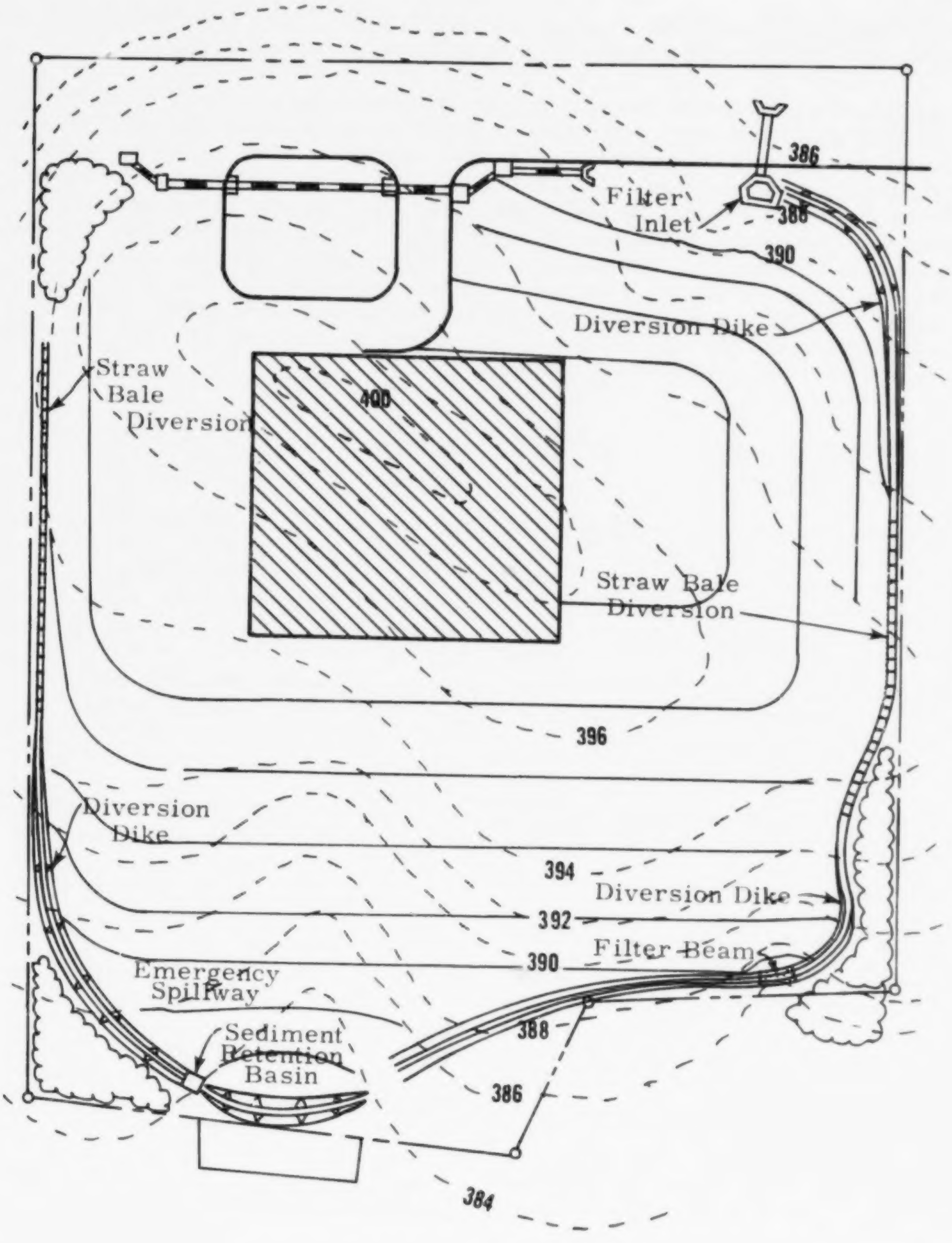
386
Filter Inlet
388
390
Diversion Dike
Straw Bale Diversion
400
Straw Bale Diversion
396
Diversion Dike
394
Diversion Dike
392
Filter Beam
390
Emergency Spillway
Sediment Retention Basin
388
386
384

FIGURE 21. Example of a sediment and erosion control plan

of the contractor and the amount of critical area, such as steep slopes and areas of high soil erodibility, present in the watershed.

A factor which must be considered when scheduling areas to be developed is the relationship of vegetative stabilization to climatic factors. In areas having severe exposure problems or exhibiting severe erosional problems, it is desirable to schedule the development so that it begins in a period of low precipitation and is completed near the beginning of a period favorable to the establishment of vegetation. This consideration should also apply to woodland areas, where development during the dormant winter months is more desirable from the standpoint of tree preservation. Conversely, it is more desirable to develop areas adjacent to major floodplains during the growing season, since the natural vegetative filter strips will be more functional at this time.

2. Location, Construction, and Maintenance of Sediment Retention Structures

The same site maps which delineate the sequence of development must also show the location of all sediment retention structures. The plan documents must indicate the sequence of the construction of these structures with relation to the specific areas. For example, it is required that all sediment structures scheduled for natural waterways in a development area be installed prior to the initiation of clearing and grading operations. When the development area does not coincide with the watershed boundaries, it may be necessary to also construct sediment retention structures outside the limits of grading prior to the start of construction.

Contracts and development plans should clearly indicate the contractor's responsibilities for maintaining the sediment retention structures.

3. Traffic Control

This is a particularly important requirement in woodland developments where uncontrolled traffic can cause severe tree damage (Appendix D).

Those areas, such as vegetative filter strips along waterways and all undisturbed open spaces, must be delineated on a site map and designated as "off limits" areas for all vehicular traffic (Appendix D).

For woodland areas, the specifications must state that all vehicular traffic will stay within the roadway, access corridor, or utility rights-of-way. These rights-of-way must also be shown on the site map.

The specification must also restrict all traffic from crossing streams or stabilized drainageways except at approved stabilized crossing locations.

4. Stream Erosion

All critical areas along streams must be marked on the site maps and the recommended method of stabilization indicated. Stream stabilization work should be scheduled for periods of low precipitation during the growing season and should be performed prior to the initiation of clearing and grading operations in the watershed.

5. Planting Schedule

The erosion and sediment control plan must clearly define vegetative practices, both temporary and permanent. The plan must state and show where and when sod, temporary seeding, and permanent seeding are to be used. Specifications shall also be provided regarding ground preparation, sod quality, seed type and quality, fertilization, and mulching.

6. Grading Delays

The construction specifications must clearly define the maximum length of time that a graded area can be left uncovered after completion of grading and also after grading shut downs, such as commonly occur in some areas during the winter months. The specifications must also state what short-term stabilization practices will be performed in the event of a lengthy grading delay.

SECTION IV

OPERATIONS

A. General

Operations in these guidelines is that process by which sediment and erosion control planning is implemented. It includes the survey and stakeout that will guide all subsequent work. Clearing and rough grading are generally the first steps in which major changes in surface landscape configuration are accomplished. Utility main service construction follows the rough grading and is, in turn, followed by the actual preparation of and construction on building sites. The implementation of the sediment and erosion control plan immediately precedes, is coincident with, or immediately follows each of the operational steps listed above.

As designated on the erosion and sediment control plans, the installation of major structures may be required before any other development work can be accomplished. This is especially true in those cases where rather large sediment retention basins (Appendix B) are required. If stream channel stabilization is required, its construction may also be required before actual site development can begin.

B. Roadway Construction

Clearing for roadway construction will have been planned in detail. In the event that the site being developed is wooded, details regarding the method of removal and ultimate disposition of trees will have been established considering the legal aspects of the clearing operations, the salvage of wood products (Appendix D), and the use of some of these products in the implementation of sediment and erosion control practices (Appendix C). It is in conjunction with the clearing of trees that the protection of those trees selected for preservation must begin (Appendix D). The erection of planned fences to protect trees, the work of concerned clearing crews and heavy equipment operators, etc., must all be demonstrated in this phase of site development. Marketable timber will, of course, be removed. Fireplace wood should be stacked or removed promptly for public or private use. Woodchips generated on-site should be stockpiled for subsequent use on the site being cleared, or should be removed for use on other sites in the area that are being developed and at which the woodchips can be used immediately (Appendix C).

Special attention should be given to the completion of the "extra" clearing required for equipment travel corridors, especially along the top of cut slopes (Appendix D).

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The advent of actual grading operations provides the first opportunity to practice one of the principles of sound sediment and erosion control, minimization of the area of disturbance. This usually involves traffic control (Appendix D). Corridors for equipment travel should be established across those areas that will not be immediately denuded, especially in wooded areas. The natural filter strip areas (Appendix D) should be given special attention. Disturbance of vegetated floodplains is also to be avoided except when absolutely necessary. Instructions will have to be issued that "routes for convenience" will not be allowed and that the established equipment travel corridors are to be used. These instructions must also be enforced.

Stockpile areas will have to be selected and their integrity maintained. These stockpile areas should have been designated on the grading plan. If not, their on-site selection must be tempered with sediment and erosion control considerations, such as the direct production and delivery of sediment to waterways, damage to vegetation that is part of the total sediment and erosion control plan, and the unnecessary destruction of trees that are selected for preservation. Temporary or interim stabilization of soil stockpiles must be instituted (Appendix A). The existence of critical slopes on stockpiles must be avoided, especially if the material is easily eroded. Stockpiling in or immediately adjacent to watercourses must not be allowed because the stockpiled material will provide a direct and high volume source of sediment to storm runoff. If the stockpile(s) is large, structural practices may be required (Appendix B). If they are not incorporated into the site plan for sediment and erosion control, their design and implementation must be accomplished by on-site personnel.

Temporary vegetative measures planned for implementation on major stockpile areas should be established immediately after the stockpile operation is completed. If the stockpile is large and stage implementation of temporary vegetative cover has been planned, it should be promptly established. Proper mulching and soil stabilization in conjunction with these seeding operations should be carried out (Appendices A and D).

As the rough grading operations near completion, the installation of structural and vegetative practices must be promptly accomplished. Diversion dikes, interceptor dikes, filter berms, etc. (Appendix B), should be constructed according to plan. The use of woodchips (Appendix C) on cut and fill slopes should begin as soon as slopes become available to receive them. If chemical soil stabilization (Appendix A) has been planned, it must be accomplished as soon as the slopes are completed. The establishment of temporary vegetative cover should begin as soon as slopes become available, not after the whole grading project has been completed.

Although timely implementation of sediment and erosion control practices has not been established as a distinct practice, its importance cannot be overstressed. Each day that a potential sediment source remains unstabilized is another day that it exists as a source of pollution.

Drainageway protection, whether natural or man-made, must be an integral part of the grading operations. There is no justification for equipment travel in these watercourses. Traffic should not be allowed to cross watercourses except at specified locations (Appendix D).

As the sediment and erosion control measures and practices established to date begin to function, their maintenance must be initiated. Sediment removal from structures designed to trap and filter must begin. Inspection of practices after each rain must become a reality. Replacement of items like strawbales, woodchips, and seedbeds must be promptly accomplished in cases where they have been destroyed by a severe storm, vandalism, or deterioration.

C. Underground Utility Construction

If a detailed plan of sediment and erosion control practices has been prepared for implementation with the construction of utilities, it only remains to "put them on the ground" as the work is completed. The utility service construction must be well coordinated so that soil disturbance will be minimal and all utility construction can be completed in the shortest time possible.

From an erosion and sediment control standpoint the use of a trench for more than one utility is desirable. So is the prompt backfilling and compaction of soil in these utility trenches (Figure 22).

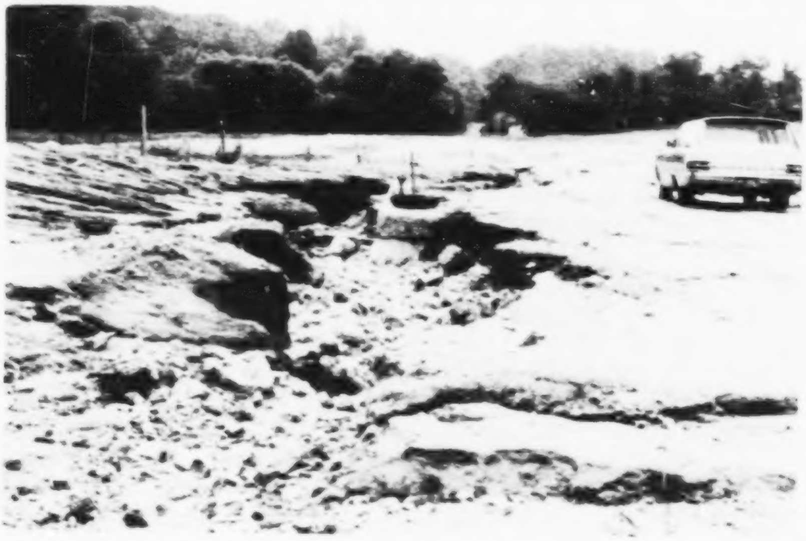

FIGURE 22. Erosion along an improperly backfilled utility trench

If additional clearing is required for the construction of utilities, it should be governed by the same considerations that have been previously listed, and tree protection and the utilization of wood products generated by clearing operations should follow the guidelines established in Appendices C and D.

Since much utility construction associated with urban development is installed in rights-of-way across private property, special care must be exercised so that damage will not be caused to natural resources or land immediately adjacent to these rights-of-way. The destruction of tree feeder roots and protective vegetation must be avoided. They are most often destroyed by cutting during excavation, burial by soil, or compaction by heavy equipment. This cannot be avoided within the construction right-of-way. It cannot be tolerated beyond the construction right-of-way.

The construction of groundwater control devices, equipment travel, and stockpiling of construction material beyond the right-of-way are the most serious causes of vegetative destruction. These transgressions against sound sediment and erosion control practice and private property can only be prevented by a more scientific approach to utility construction. Brute force techniques can no longer be tolerated.

Because flow in storm and sanitary sewer mains is maintained by gravity in most cases, these services are often constructed parallel to drainageways. For this reason, extra care during construction is required if the rules of sound sediment and erosion control are to be maintained. Excavated material must be stockpiled on the side of the trench, away from the stream channel. Flooding is less likely to remove the soil from the site as sediment if this practice is followed.

If a stockpile is to remain for some period of time, it should be stabilized. Soil stabilizing chemicals (Appendix A), temporary vegetation, interim structures (Appendix B), or special practices (Appendix D) may be required.

Traffic must be strictly limited to rights-of-way or traffic corridors, especially when construction is on or adjacent to streams and floodplains. The filtering of sediment-laden runoff by the vegetation on floodplains is an important measure in the reduction of sediment delivered to downstream areas and it must be preserved. Indiscriminate and "convenience" travel cannot be tolerated if this natural filter (Appendix D) is to continue to perform.

Pumped water management (Appendix D) is a practice that the utility contractor can use to reduce the production of sediment. In the past, most people did not consider this routine construction operation as a source of sediment pollution. The simple act of discharging pumped water onto a stabilized area is a practice that can be implemented at little or no extra cost. If ditches are required to remove water pumped from construction excavations, they must be given the same consideration as any other man-made waterway. They must be stabilized if they are not to degrade and produce sediment. Erosion and sediment control structures (Appendix B) may be required to accomplish this stabilization.

After construction in this phase of the development activity is complete, vegetation on the areas that have been disturbed must be reestablished. If permanent vegetation is planned, it must be established as rapidly as possible. If the completion of the construction activities does not coincide with a season in which permanent vegetation can be started, an interim or temporary program is required. This can include soil stabilization (Appendix A), mulching (Appendix D), or the establishment of filter strips or the use of scarification (Appendix D). In any case, sediment and erosion controls must be installed promptly and their maintenance must be assured.

D. Building Construction

As construction begins, the implementation of that part of the sediment and erosion control program scheduled for this segment of the development activities will also get underway. On wooded lots, the first task to be accomplished is the marking of the trees that are to be preserved. Fencing is recommended if the trees marked for protection are to be given the maximum possible protection. As indicated elsewhere in this document, concern for trees is desirable both from an aesthetic as well as from a sediment and erosion control point. Trees do protect the soil. Where required, the removal of trees can be accomplished in a manner that is acceptable from an environmental standpoint and from an operations standpoint.

As the lot takes its final physical shape, tree preservation activities (Appendix D) will have to begin. The disposal of the wood products generated during the clearing operation should follow the recommendations of Appendices C and D. Lumber can be marketed. Fireplace wood can be reserved for use in neighborhood housing (Figure 23). Woodchips should be returned to the lot as part of the erosion control plan (Figure 24). Stumps should be removed by stump cutting (Appendix D) rather than dozing.

If homes are being constructed with basements, the problems associated with basement excavation must be resolved. Access to the excavation must be closely controlled. The access ramp must be constructed in such a manner that remaining trees are not damaged. The material removed from the basement excavation must be selectively stockpiled in areas where a minimum of sediment will be generated and where other damage will not result from the piled earth (Figure 25). Natural drainageways must be protected at all times and piling soil excavated from a basement in a drainageway cannot be tolerated.

FIGURE 23. Firewood produced during clearing operations

FIGURE 24. Use of woodchips as an interim erosion control practice on a homesite

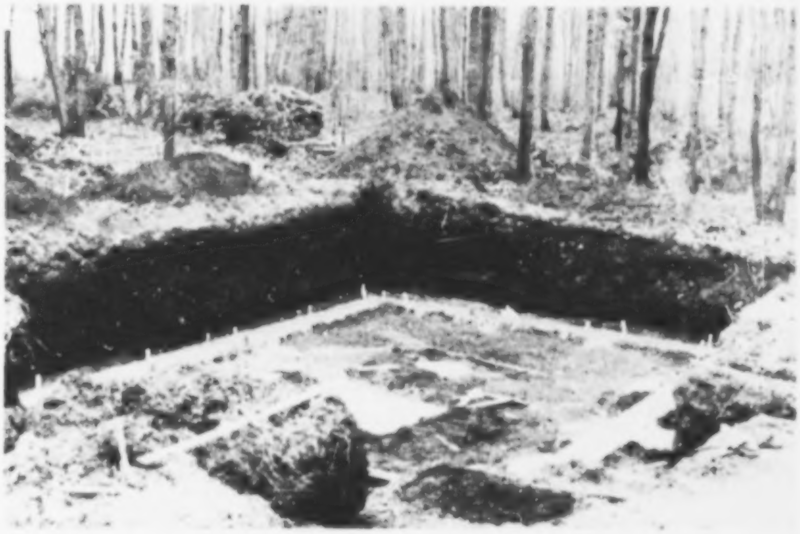

FIGURE 25. Selective stockpiling to protect trees

Construction of basement structures should begin as soon as the excavation is complete so that backfilling or other disposition of the unstabilized soil can be promptly accomplished. If stockpiles are to remain for some time, they should be stabilized (Appendix A) or sufficient protection should be provided by other means (filter strips - Appendix D; mulching - Appendix C) to insure that they do not produce sediment for removal and delivery to downstream sites.

Short term site stabilization can begin as soon as the basement spoil has been spread and/or removed from the site and the final surface configuration is complete. Temporary seeding and mulching (Appendix C), soil stabilization with chemicals (Appendix A), and woodchips (Appendix C) can all be used to advantage. In areas that are subject to foot or wheeled vehicle traffic, a four-inch layer of woodchips will provide the best method of protection.

Traffic on the lot should be kept to an absolute minimum. Delivery of material will, of course, be required. This traffic should enter and leave on a designated access route. Stockpiling locations should be carefully selected so that sediment and erosion control practices are not destroyed (Figure 26). Passenger vehicle traffic should be discouraged. Workmen should walk from the street rather than drive and park on stabilized areas. Early completion of the access drive(s) will provide a stabilized route for light vehicle traffic and this practice is encouraged.

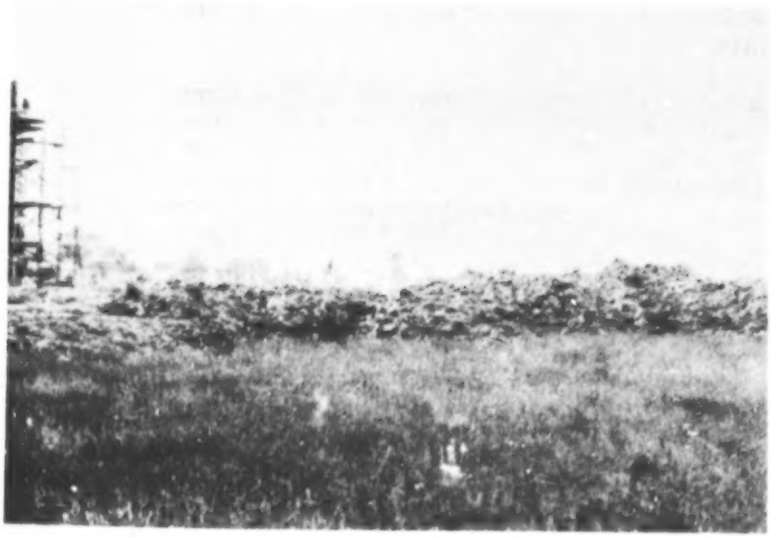

FIGURE 26. Stockpile with a natural filter strip located downslope

When construction is complete, final grading for landscaping purposes will begin. Again, tree protection will have to be a principal concern. The concern is now one of tree preservation for ultimate use and enjoyment by the new owner. It is no less important, however, that the tree preservation notations (Appendix D) be considered to insure that no damage is incurred at this late date, because trees damaged during this stage of the operations phase of development will directly affect the reputation of the builder. With this in mind, items such as filling over tree root systems or cutting feeder roots take on great importance.

The only task remaining after final grading is complete is the establishment of permanent ground cover. This stage should begin by collecting representative surface soil samples for testing, analysis, and nutrient recommendations. This is especially true in areas that have been filled since the fill soil has probably not been tested and its deficiencies will have to be determined if a good vegetative stand is to be established. Guidance for soil sample collection and testing can be obtained from the county extension agent.

While results of soil testing are pending, the plans for the care and feeding of trees on wooded lots can be started. Individuals should seek guidance from the state and federal forest services or professional silvaculturists. This effort is important since the original woodland environment has been changed to a parkland environment and this change can adversely affect trees that remain.

Sod is often placed to quickly establish cover on a prepared surface. This surface should be prepared as if it were to be seeded if optimum results are to be realized. The recommendations resulting from soil sample testing should be followed. Turf establishment by sodding can be accomplished at any season except winter in the temperate climate.

If seeding is selected as the method of establishing turf, the soil sample testing recommendations should be incorporated into the preparation of the seedbed. Mulching of the seeded area (Appendices A and C) will greatly enhance the germination and growth of a good stand. If long fiber mulch is selected, it should be securely tacked (Appendix A) or anchored in place by mechanical methods (Appendix D) or nettings (Appendix C).

In the event that final lot grading is completed in a season that is not compatible with the establishment of permanent vegetative cover, temporary practices should be used to stabilize the soil until a satisfactory seeding, germination, and growth season arrives. Chemical soil stabilizers (Appendix A), the use of temporary vegetation such as quick growing annual grasses, and mulching (Appendix C) can all be used to effect temporary control of erosion and sediment production.

Areas of concentrated runoff, i.e., drip lines, downspouts, etc., will require additional effort if they are not to adversely affect attempts to establish vegetative cover (Figures 27 and 28). The use of mulch and/or mulch blankets under driplines (Appendix C) will dissipate the energy of falling water and allow the growth of new seed. Discharge to splash blocks, dry wells, and the removal of water from downspouts to stabilized areas by conduit should all be considered when providing protection to newly seeded areas.

When the final ground cover has been established, the development of the site is complete and the satisfaction of a job well done can be enjoyed. If the development has been completed in a manner that is consistent with good environmental control through the implementation of a sound sediment and erosion control plan, the satisfaction gained can be even greater.

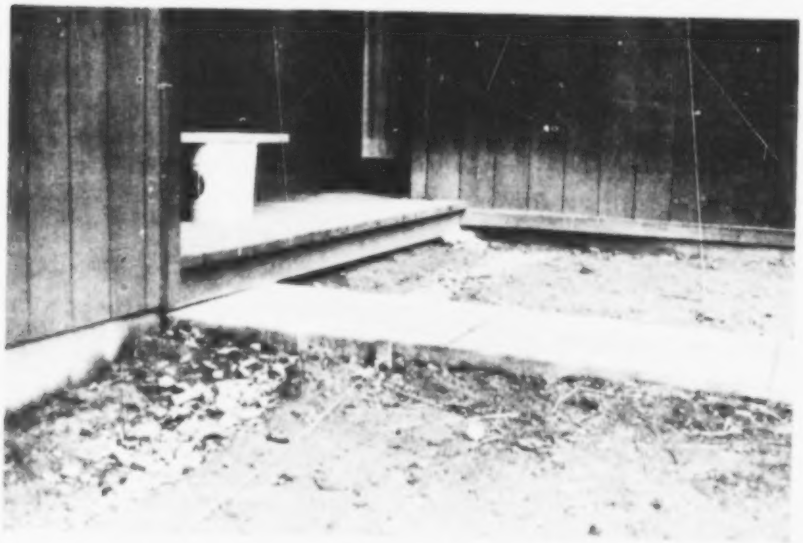

FIGURE 27. Erosion at an unprotected dripline

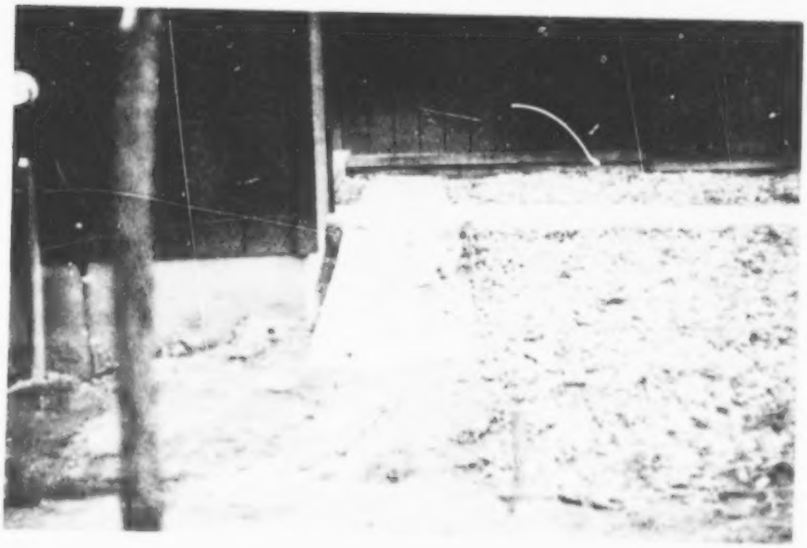

FIGURE 28. Dripline protection with a fiber glass blanket

SECTION V

MAINTENANCE

Maintenance regarding sediment and erosion control is an area that has received little more than lip service in the past. Practices are installed but little thought has been given to maintaining them in a condition that allows them to function properly.

Heavy equipment is greased and lubricants are changed regularly in an effort to get optimum equipment performance. Repairs are kept to a minimum if lubrication and other maintenance schedules are carried out. Similarly, sediment and erosion control practices will not function properly throughout their designed life span if they are not maintained. Whether the practice is vegetative or structural, minimum maintenance schedules must be implemented if the practices are to continue to function in the control of erosion and sediment pollution.

The most important maintenance practice is the timely cleanout and stable disposition of trapped sediment from sediment retention basins. Many areas have specially established criteria or schedules that provide guidance as to when a basin should be cleaned. A rule of thumb that can be used is to clean out a basin when it has lost 50 percent of its storage capacity due to sediment deposition. Filling to depths greater than half greatly reduces the capacity of the basin to retain runoff long enough for sediment to be deposited before it moves downstream.

The sediment removal operation must also consider the stable disposition of the soil removed from the basin. Indiscriminate piling or dumping is unacceptable because the sediment is likely to be moved back into the storm drainage system by successive storm events. When this is the case, the material is again a pollutant.

Disposition behind a protective berm or filter strip will often suffice if the quantities involved are not large and can be affected by dragline and truck transport. In basins with larger capacities, the services of professionals experienced in the handling and disposition of sediment should be retained.

Appendix B contains a brief description of the minimum maintenance required for each of the various structural practices. Many require work to restore them after each storm. Where this is the case, nothing short of compliance will suffice if the structure is to continue to function. Responsibility for maintenance must be formally assigned on a development site of any size. It must be assigned to an individual who is knowledgeable in maintenance requirements and who has access to equipment, material, and funds required to sustain the maintenance schedule. Informal implementation of structural maintenance results in no maintenance.

Several of the practices incorporated into the appendices cannot survive if they are subjected to foot or vehicle traffic. In areas where these practices are installed, the prohibition of traffic must be maintained. This can only be accomplished by an information distribution program that "spreads the word" to all persons working in the area.

Vegetative practices require maintenance in two general areas. The first is periodic refertilization. Too often a stand of vegetative cover established in the sediment and erosion control program is allowed to deteriorate and become ineffective because it is nutritionally starved. A fertilization maintenance program should be established and carried out as the development of the area proceeds.

Areas where failures have been experienced in the establishment of vegetative protection must be promptly treated. If the failure is due to rilling or gully formation, temporary structural practices such as flexible downdrains and section slope drains (Appendix B) can be utilized while arrangements for permanent control are made. The re-establishment of permanent vegetative cover should be the ultimate goal. However, changed site conditions may require the installation of some sort of permanent structural control like level spreaders, diversions, etc. (Appendix B). Any remedial treatment should be initiated as soon as possible in an effort to keep the area requiring maintenance work to a minimum. Timely maintenance will also reduce costs in the long run.

SECTION VI

ACKNOWLEDGEMENTS

These guidelines were prepared under the joint sponsorship of the U.S. Environmental Protection Agency and the Maryland Department of Water Resources by Hittman Associates, Inc., of Columbia, Maryland. Sincere thanks are extended to Mr. Ernst Hall, Chief, Pollution Control Analysis Section, EPA; Mr. John J. Mulhern, Project Manager, EPA; and Dr. H.R. Thacker, Project Officer, EPA, for their support and guidance throughout the period of basic data acquisition and document preparation.

Special guidance was provided by Mr. Marshall T. Augustine, Sedimentation Specialist, Maryland Department of Water Resources, and his participation and assistance in the preparation of this document is gratefully acknowledged. The editorial comment and support of Mr. Albert E. Sanderson, Jr., Coordinator for Research, Maryland Department of Water Resources, is acknowledged with sincere thanks.

The contributions provided to this program by the Howard Research and Development Corporation, the developers of Columbia, Maryland, and the Columbia Parks and Recreation Association, Inc., are also gratefully acknowledged.

SECTION VII

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SECTION VIII

GLOSSARY

A.A.S.H.O. - American Association of State Highway Officials.

Abrasion - The wearing away by friction, the chief agents being currents of water or wind laden with sand and other rock debris and glaciers.

Abutment - The point of contact between the support and the thing supported.

Acid soil - A soil with a preponderance of hydrogen ions, and probably of aluminum in proportion to hydroxyl ions. Specifically, soil with a pH value less than 7.0. For most practical purposes, a soil with a pH value less than 6.6. The pH values obtained vary greatly with the method used; consequently, there is no unanimous agreement on what constitutes an acid soil. The term is usually applied to the surface layer or to the root zone unless specified otherwise.

Adverse - Hostile; unfavorable; harmful.

AEROSPRAY® 52 BINDER - See Appendix A, p. 81

Aesthetic - Of beauty; beautiful.

Air entraining - Air trapping; holding unusual quantities of air in a mixture.

Annual plant (annuals) - A plant that completes its life cycle and dies in 1 year or less.

AQUATAIN - See Appendix A, p. 83

Articulate - To joint; jointed.

Assess - Set a rate; to set the amount of (damages, a fine, etc.).

Available water-holding capacity - The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil. Commonly defined as the difference between the percentage of soil water at field capacity and the percentage at wilting point. This difference multiplied by the bulk density and divided by 100 gives a value in surface inches of water per inch depth of soil.

Bedrock - The more or less solid rock in place either on or beneath the surface of the earth. It may be soft or hard and have a smooth or irregular surface.

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Berm - A shelf that breaks the continuity of a slope.

Channel - A natural stream that conveys water; a ditch or channel excavated for the flow of water.

CHECK DAM - See Appendix B, p. 98

CHUTES - See Appendix B, p. 101

Clay - 1: A mineral soil separate consisting of particles less than 0.002 millimeter in equivalent diameter. 2: A soil textural class. 3: (engineering) A fine-grained soil that has a high plasticity index in relation to the liquid limits.

Clear cut - The removal of the entire timber stand on the area cut. Contrast with selective cutting.

Coherent - Sticking together; having cohesion.

Cohesive - Holding together - Force holding a solid or liquid together, owing to attraction between like molecules.

Coincide - To take up the same place in space; be exactly alike in shape, position, and area; to occur at the same time; take up the same period of time. To agree; be identical.

Colloid, soil - Colloid refers to organic or inorganic matter having very small particle size and a correspondingly large surface area per unit of mass. Most colloidal particles are too small to be seen with the ordinary compound microscope.

Compaction - To unite firmly; the act or process of becoming compact, usually applied in geology to the changing of loose sediments into hard, firm rock. With respect to construction work with soils, engineering compaction is any process by which the soil grains are rearranged to decrease void space and bring them into closer contact with one another, thereby increasing the weight of solid material per cubic foot.

Compatible - Capable of existing together; in agreement.

Competent rock - Beds or strata which, because of massiveness or inherent strength, are able to withstand great pressure or stress; hard.

Conduit - Any channel intended for the conveyance of water, whether open or closed.

Configuration - Arrangement of parts; outline.

Conservation - The protection, improvement, and use of natural resources according to principles that will assure their highest economic and social benefits.

CONSTRUCTION COORDINATION - See Appendix D, p. 194

Contour - 1: An imaginary line on the surface of the earth connecting points of the same elevation. 2: A line drawn on a map connecting points of the same elevation.

Contour interval - The vertical distance between contour lines.

Convenience - A condition personally favorable or suitable; advantage; handy.

Cool season plant - A plant that makes its major growth during the cool portion of the year, primarily in the spring but in some localities in the winter.

Coordinate - To bring into proper order or relation; harmonize; adjust; function harmoniously.

®CURASOL AE - See Appendix A, p. 85

®CURASOL AH - See Appendix A, p. 87

DCA-70 - See Appendix A, p. 89

Deciduous plant - A plant that sheds all its leaves every year at a certain season.

Deficiency - The amount by which a series of quantities falls short of a given demand, normal, or other criterion; opposite of excess.

Deleterious - Harmful to health, well being; injurious.

Delineation - A drawing; sketch; description.

Density - Mass or quantity per unit of volume, close; compact.

Denuded - Bare; naked; stripped.

Detention practice - Practice or structure installed for the purpose of temporary storage of stream flow or runoff and for releasing the stored water at controlled rates.

Discharge - Rate of flow, specifically fluid flow; a volume of fluid passing a point per unit time commonly expressed as cubic feet per second, million gallons per day, gallons per minute, or cubic meters per second.

Dissipate - To scatter; disperse, cause to vanish.

Diversion - Channel constructed across the slope for the purpose of intercepting surface runoff; changing the accustomed course of all or part of a stream.

DIVERSION DIKE - See Appendix B, p. 105

Dolomitic - Of or pertaining to dolomite - a sedimentary rock of magnesium and calcium carbonate.

Downcutting - When the debris supplied to a stream is less than its capacity for carrying loads, the stream abrades (erodes) its bed and is said to be a downcutting stream.

Drainage basin - All land and water within the confines of a drainage divide.

Drainage pattern - The configuration or arrangement of streams within a drainage basin or other area.

Drip line - An imaginary line on the ground surface that corresponds to the farthest lateral extension of the branches of a tree. The area where water falling from a roof strikes the ground.

Droughty - Exhibiting a poor moisture-holding capacity due to excessively high permeability and a low percentage of fines.

Duff - The more or less firm organic layer on top of mineral soil, consisting of fallen vegetative matter in the process of decomposition, including everything from pure humus below to the litter on the surface. Duff is a general, nonspecific term.

Ecology - The study of the interrelationships of organisms to one another and to the environment.

Empirical - Relying or based solely on experiment and observation.

Enhance - To make greater, as in cost, value, effectiveness. To increase.

Environment - The sum total of all the external conditions that may act upon an organism or community to influence its development or existence.

Erodible - Susceptible to erosion.

Erosion - 1: The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. 2: Detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

EROSION CHECK - See Appendix B, p. 109

Evaporation - The process by which a liquid is changed to a vapor or gas.

EXCELSIOR BLANKET - See Appendix C, p. 164

Expansive - Tending to expand; that can expand.

Expedient - Convenient; suited to the circumstances or the occasion.

FABRIFORM® - See Appendix B, p. 114

Fertility - The quality of a soil that enables it to provide nutrients in adequate amounts and in proper balance for the growth of specified plants when other growth factors, such as light, moisture, temperature, and the physical condition of the soil,are favorable.

FIBER GLASS MATTING - See Appendix C, p. 167

Fibrous root system - A plant root system having a large number of small, finely divided, widely spreading roots but no large individual roots. Typified by grass root system. Contrast with taproot system.

FILTER BERM - See Appendix B, p. 119

FILTER INLET - See Appendix B, p. 123

Filter strip - Strip of vegetation that retards flow of runoff water, causing deposition of transported material, thereby reducing sediment flow.

Fines - Silt and clay sized. Soil particles less than 0.074 mm (#200 sieve) in diameter.

FLEXIBLE DOWNDRAIN - See Appendix B, p. 128

Floodplain - Nearly level land situated on either side of channel which is subject to overflow flooding.

FLUME - See Appendix B, p. 101

Flush - Even or level.

GABIONS - See Appendix B, p. 132

Geology - The science of the earth.

Germination - Sprouting; beginning of growth.

Grommet - A metal eyelet in fabric.

GLASSROOT® - See Appendix C, p. 169

Gradation - The frequency distribution of the various sized grains that constitute sediment, soil, or other material.

Grade control structure - A mechanical device or structure used to control the slope of a channel.

Gradient - Change of elevation, velocity, pressure, or other characteristics per unit length; slope.

Grain size gradation - The gradation of soil particles.

Groin - A shore-protection and improvement structure. It is narrow in width compared to its length.

Groundwater - Phreatic water or subsurface water in the zone of saturation.

Grouted - Having the area between pieces of rock, brick, etc., filled with mortar or concrete.

Gully - A channel or miniature valley cut by concentrated runoff but through which water commonly flows only during and immediately after heavy rains or during the melting of snow. A gully may be dendritic or branching or it may be linear, rather long, narrow, and of uniform width. The distinction between gully and rill is one of depth. A gully is sufficiently deep that it would not be obliterated by normal tillage operations, whereas a rill is of lesser depth and would be smoothed by ordinary farm tillage.

Habitat - The environment in which the life needs of a plant or animal are supplied.

HAY - See Appendix C, p. 183

Herbaceous - Of any flowering plant except those developing persistent woody bases and stems above ground.

Hydraulic - Operated by the movement and force of liquid.

Hydrology - The science of water, its properties, laws, and distribution.

Impoundment - An enclosed body of water, usually man-made.

Inconsistent - Not uniform; not holding to the same principles or practice.

Indiscriminate - Confused; random, making no distinctions.

Indurated - Rendered hard; hardened by heat, pressure, or cementation. Soil material rendered into a hard mass that will not soften on wetting.

Inferred - Concluded or decided from something known or assumed; derived by reasoning; drawn as a conclusion.

Infiltration - The flow of a liquid into a substance through pores or other openings, connoting flow into a soil in contradistinction to the word percolation which connotes flow through a porous substance.

Informal - Not formal; casual; easy.

Inhibit - To hold back, restrain, curb; to prohibit; forbid, to suppress.

Insolation - The radiation from the sun received by the earth's surface.

Integral - Necessary for completeness; essential, complete.

Integration - Making whole or complete by adding or bringing together parts, unify.

Integrity - The quality or state of being complete; unbroken condition; wholeness; entirety.

INTERCEPTOR DIKE - See Appendix B, p. 136

Interface - A surface that lies between two parts of matter or space and forms their common boundary.

Interim - Temporary; provisional.

Intermittent stream - A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long-continued supply from melting snow or other sources. It is dry for a large part of the year, ordinarily more than 3 months.

JUTE NETTING - See Appendix C, p. 172

Lateral - Of, at, from or toward the side; sideways.

Legume - A member of the legume or pulse family, Leguminosae. One of the most important and widely distributed plant families. The fruit is a "legume" or pod that opens along two sutures when ripe. Flowers are usually papilionaceous (butterflylike). Leaves are alternate, have stipules, and are usually compound. Includes many valuable food and forage species, such as the peas, beans, peanuts, clovers, alfalfas, sweet clovers, lespedezas, vetches, and kudzu. Practically all legumes are nitrogen-fixing plants.

Levee - An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands.

LEVEL SPREADER - See Appendix B, p. 140

LIQUID ASPHALT - See Appendix A, p. 91

Maintenance - Upkeep; support.

Meander - One of a series of somewhat regular and looplike bends in the course of a stream.

Migration - The movement from one place to another.

Moisture-density relationship - The relationship in a soil between its moisture content and its density at that moisture content.

Monolithic - Massively solid, single, and uniform.

Mottled - Soil horizons irregularly marked with spots of color. A common cause of mottling is impeded drainage, although there are other causes, such as soil development from an unevenly weathered rock. The weathering of different kinds of minerals may cause mottling.

Mulch - A natural or artificial layer of plant residue or other materials, such as sand or paper, on the soil surface.

MULCH ANCHORING - See Appendix D, p. 195

MULCH BLANKET - See Appendix C, p. 176

NETTING - See Appendix C, p. 179

Nonphytotoxic - Not poisonous to plants.

Nontoxic - Not poisonous.

Ordinance - A statute (law) enacted by the legislative department of a government.

Organic matter - The organic fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. Commonly determined as the amount of organic material contained in a soil sample passed through a 2-millimeter sieve.

Oriented - Shown or established relationship with others by being placed or arranged in a certain manner.

Orthophotograph - An aerial photograph from which all distortion due to tip, tilt, and parallax has been removed. An aerial photograph from which or upon which accurate horizontal measurements can be made.

Outcrop - To come to or be exposed on the surface.

Outfall - Point where water flows from a conduit, stream, or drain.

Overfall - Aprupt change in stream channel elevation; the part of a dam or weir over which the water flows.

Parkland environment - A formerly wooded area from which certain trees have been removed and into which man-made structures or buildings have been introduced.

Perched watertable - The surface of a local zone of saturation held above the main body of groundwater by an impermeable layer or stratum usually clay, and separated from the main body of groundwater by an unsaturated zone.

Permanent stream - A stream that carries water throughout the year.

Permeable - Having a texture that permits water to move through it.

Permeability - The quality of a soil horizon that enables water or air to move through it. The permeability of a soil may be limited by the presence of one nearly impermeable horizon even though the others are permeable.

Perspective - A proper evaluation with proportional importance given to the component parts.

PETROSET®SB - See Appendix A, p. 93

pH - A numerical measure of the acidity or hydrogen ion activity of a soil. The neutral point is pH 7.0. All pH values below 7.0 are acid and all above 7.0 are alkaline.

Phase development - Development by distinct and separate units.

Photo mosaic - A picture formed by matching together parts of a number of overlapping vertical aerial photographs.

Piling - A long, heavy timber or beam driven or placed in the ground to support a structure.

Piping - Removal of soil material through subsurface flow channels or "pipes" developed by seepage water.

PLASTIC FILTER SHEET - See Appendix C, p. 182

Pollutant - Something that pollutes.

Pollute - Impair the purity of.

Porous - Containing voids, pores, interstices, or other openings which may or may not interconnect.

Prohibition - An order or law forbidding something to be done.

PUMPED WATER MANAGEMENT - See Appendix D, p. 196

Quadrangle - The area of land charted on each of the atlas sheets published by the United State Geological Survey.

Ratio - A fixed relation in degree, number, etc., between two similar things; proportion. The quotient of one quantity divided by another of the same kind, and usually expressed as a fraction.

Reconnaissance - A general examination or survey of a region with reference to its main features, usually as a preliminary to a more detailed survey.

Rejuvenate - To render young again. To renew erosive activity.

Remedial - Providing, or intended to provide, a remedy.

Remedy - Something that corrects; relief.

Revetment - Facing of stone or other material, either permanent or temporary, placed along the edge of a stream to stabilize the bank and to protect it from the erosive action of the stream.

Right-of-way - Right of passage, as over another's property. A route that is lawful to use. A strip of land acquired for transport or utility construction.

Rill - A small, intermittent water course with steep sides, usually only a few inches deep and, hence, no obstacle to tillage operations.

Riprap - Broken rock, cobbles, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves); also applied to brush or pole mattresses, or brush and stone, or other similar materials used for soil erosion control.

Rootmat - A dense or thick concentration of the roots of vegetation.

ROUGHNESS - See Appendix D, p. 199

Runoff - That portion of the precipitation on a drainage area that is discharged from the area in stream channels. Types include surface runoff, groundwater runoff, or seepage.

Sand - A soil particle between 0.074 (#200 sieve) and 4.76 (#4 sieve) millimeters in diameter.

SANDBAG SEDIMENT BARRIER - See Appendix B, p. 142

Scarification - To loosen or stir the topsoil without turning it over as with a plow or shovel.

SCARIFICATION - See Appendix D, p. 199

SECTIONAL DOWNDRAIN - See Appendix B, p. 145

Sedge - Any of several coarse, grasslike plants usually growing in tufts or clumps in wet ground.

Sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

Sedimentation - The depositing of sediment.

SEDIMENT RETENTION BASIN - See Appendix B, p. 148

Seedbed - The soil prepared by natural or artificial means to promote the germination of seed and the growth of seedlings.

Sheet flow - Water, usually storm runoff, flowing in a thin layer over the ground surface.

Shrink-swell potential - Susceptibility to volume change due to loss or gain in moisture content.

Silt - Soil particles between 0.074 millimeter (#200 sieve) and 0.002 millimeter in equivalent diameter.

Silviculture - Forestry.

Slaking - The crumbling or disintegration of earth materials when exposed to air or moisture.

Slough - Come off; fall away.

Soil - 1: The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. 2: The unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time and producing a product-soil-that differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics. 3: A kind of soil is the collection of soils that are alike in specified combinations of characteristics. Kinds of soil are given names in the system of soil classification. The terms "the soil" and "soil" are collective terms used for all soils, equivalent to the word "vegetation" for all plants.

Soil horizon - A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics, such as color, structure, texture, consistence, kinds and numbers of organisms present, degree of acidity or alkalinity, etc.

Soil structure - The combination or arrangement of primary soil particles into secondary particles, units, or peds. The secondary units are characterized and classified on the basis of size, shape, and degree of distinctness into classes, types, and grades, respectively.

Sprig - To plant a portion of the stem and root of grass.

Stage implementation - To accomplish by period, level, or degree.

Staged - By period, level, or degree.

Stereoscope - An instrument that gives a three-dimensional effect to photographs viewed through it.

STRAW - See Appendix C, p. 183

STRAWBALE SEDIMENT BARRIER - See Appendix B, p. 159

Stress - Strain; pressure; especially a force exerted upon a thing that tends to strain or deform its shape or well-being.

STUMP REMOVAL - See Appendix D, p. 203

Subwatershed - A watershed subdivision of unspecified size that forms a convenient natural unit.

Swale - A hollow or depression.

Tacking (mulch) - The process of binding mulch fibers together by the addition of a sprayed chemical compound.

Tangential - Touching, turned aside from a straight course.

Technology - Applied science.

Tenacity - Firmness of hold, cohesiveness, adhesiveness, or persistence.

TERRA TACK - See Appendix A, p. 95

Terrace - An embankment or combination of an embankment and channel constructed across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope. Terraces or terrace systems may be classified by their alignment, gradient, outlet, and cross-section. Alignment is parallel or nonparallel. Gradient may be level, uniformly graded, or variably graded. Grade is often incorporated to permit paralleling the terraces. Outlets may be soil infiltration only, vegetated waterways, tile outlets, or combinations of these. Cross-sections may be narrow base, broad base, bench, steep backslope, flat channel, or channel.

Tetrahedron - A solid figure with four triangular surfaces.

Timely - Well timed; opportune.

TRAFFIC CONTROL - See Appendix D, p. 206

Transition - Passing from one condition or form to another.

Trap efficiency - The capability of a reservoir to trap sediment.

TREE PROTECTION - See Appendix D, p. 211

Unified Soil Classification System - A classification system based on the identification of soils according to their particle size, gradation, plasticity index, and liquid limit.

Uplift - The upward pressure of water on the base of a structure.

Utilidor - A conduit, trench, tunnel, etc., that is used by more than one utility or service.

VEGETATIVE FILTER STRIP - See Appendix D, p. 218

Warm season plant - A plant that completes most of its growth during the warm portion of the year, generally late spring and summer.

Water table - The upper surface of groundwater or that level below which the soil is saturated with water; locus of points in soil water at which the hydraulic pressure is equal to atmospheric pressure.

Watershed - All the land and water within the confines of a drainage divide.

Waterway - A natural course or constructed channel for the flow of water.

Well drained - Allows water movement readily but not rapidly.

Well graded soil - A soil in which a continuous distribution of grain sizes from the coarsest to the finest components exist in such proportions that the successively smaller grains just fill in the spaces between the larger grains.

Woodchipper - A machine that uses cutting devices to reduce wood to small chips.

WOODCHIPS - See Appendix C, p. 186

WOODFIBER MULCH - See Appendix C, p. 190

WOODLAND CLEARING AND EXCAVATION - See Appendix D, p. 222

Woodland environment - Any land used primarily for growing trees and shrubs. Woodland includes, in addition to what is ordinarily termed "forest" or "forest plantations," shelterbelts, windbreaks, wide hedgerows containing woodland species for wildlife food or cover, stream and other banks with woodland cover, etc. It also includes farmland and other lands on cover, etc. It also includes farmland and other lands on which woody vegetation is to be established and maintained.

Zone of aeration - That soil zone in which some of the pores are filled with air. Unsaturated.

Zone of saturation - That soil zone in which all of the pores are filled with water. Saturated.

SECTION IX

APPENDICES

Page No.

A. Chemical Soil Stabilizers, Mulches, and Mulch Tacks 78

B. Erosion and Sediment Control Structures 97

C. Fiber Mulches, Mulch Blankets, and Nettings 163

D. Special Erosion and Sediment Control Practices . . . 193

Product and/or practice listings in the Appendices do not constitute endorsement by the Environmental Protection Agency. All of the products listed in these Appendices are available on the commercial market and they have been used according to the manufacturers' recommendations. Requests for specific information regarding use, handling limitations, toxicity, etc., should be directed to the manufacturer.

It is also understood that this listing may not be all inclusive. Other similar products and/or practices may be available for use and their exclusion is in no manner a reflection on their utility or quality.

APPENDIX A

CHEMICAL SOIL STABILIZERS, MULCHES, AND MULCH TACKS

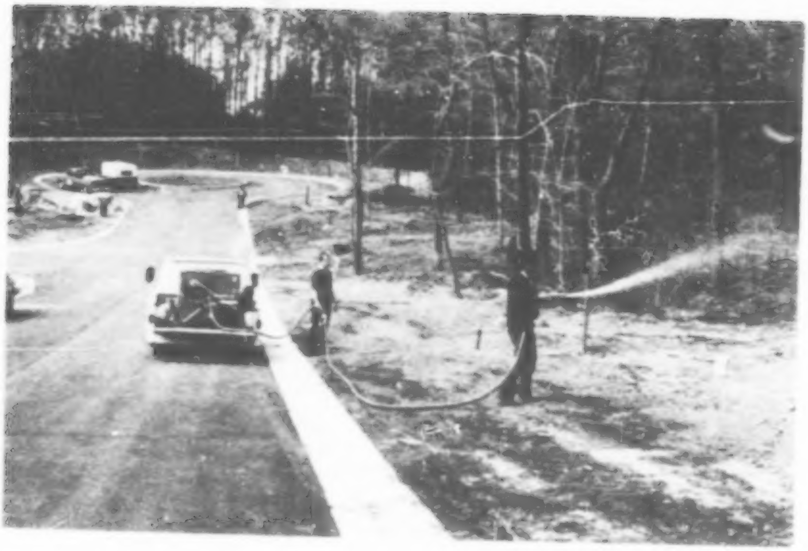


FIGURE A-1. Chemical soil stabilizer being applied to an area that will be seeded at a later date

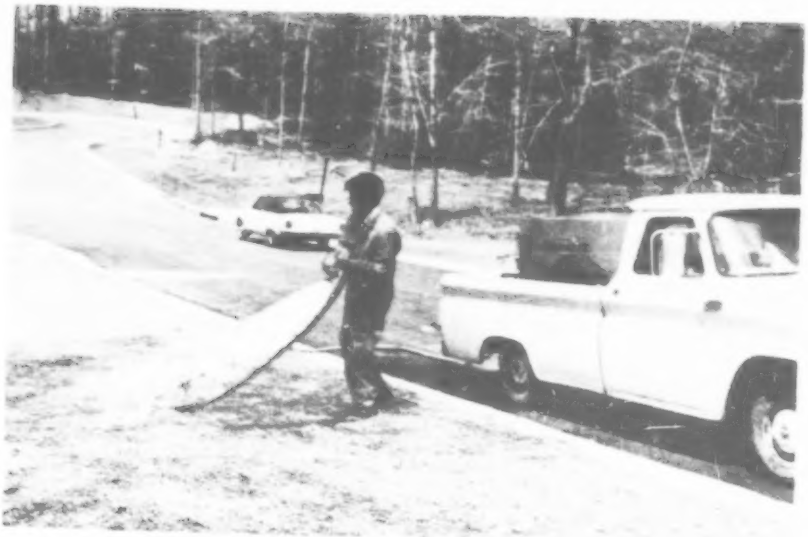


FIGURE A-2. Chemical mulch tack being applied to straw mulch

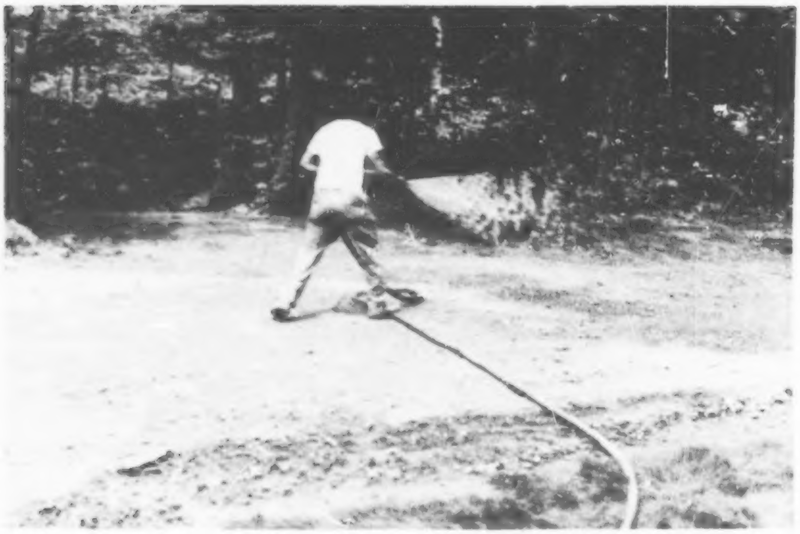


FIGURE A-3. Chemical mulch being applied in a hydroseeder slurry with lime, fertilizer, and seed

NOTES:

AEROSPRAY® 52 BINDER

Technical Information

DESCRIPTION:

AEROSPRAY® 52 BINDER is a milk-white colored, viscous, water dispersible alkyd emulsion. It is nontoxic and nonphytotoxic and the pH is 8-9.

OBJECTIVE:

Temporary Soil Stabilization - On denuded areas it penetrates the soil and binds soil particles into a coherent mass that reduces erosion by water.

Chemical Mulch - On seeded areas it penetrates the soil and binds soil particles into a coherent mass. Water and air movement into the soil is maintained.

WHERE USED:

AEROSPRAY® 52 BINDER is used as a temporary soil stabilizer and mulch on all types of soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

Various dilution ratios and application rates have been developed by the manufacturer and this chemical should be applied in accordance with the manufacturer's recommendations if optimum results are to be achieved. Some general guidelines are listed below. On steeply inclined, exposed slopes AEROSPRAY® 52 BINDER should be applied in concentrated form at the rate of one gallon per 100 square feet. When used on a seedbed, it is applied at a rate of 30-45 gallons of concentrate per acre in dilution ratios that vary up to 10 parts of water to one of chemical.

MEANS OF APPLICATION:

In general, it can be applied with any nonair entraining equipment employed for applying liquid fertilizer, asphalt emulsions, and water. It can also be applied on small plots with garden type hand sprayers. Hydroseeder agitation devices should be disengaged after initial mixing of the chemical and water to minimize foaming.

CURING TIME:

AEROSPRAY® 52 BINDER dries in four hours at 90°F, and in eight hours at 60°F and 50 percent relative humidity.

HANDLING LIMITATIONS:

Will freeze, but freezing will not damage the product.

MANUFACTURER:

American Cyanamid Company
Industrial Chemicals and Plastics Division
Wayne, New Jersey 07970

NOTES

AQUATAIN

Technical Information

DESCRIPTION:

AQUATAIN is a water dispersible liquid concentrate containing sodium polypectate, glycerin, and ammonia. It is nontoxic and nonflammable.

OBJECTIVE:

Chemical Mulch - Partially binds surface soil in order to reduce erosion and evaporation losses and thereby favorably affect the development of a permanent vegetative cover. May be used in hydroseeder slurries as well as on preseeded areas.

WHERE USED:

AQUATAIN is used as a chemical mulch on all types of soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

AQUATAIN is generally mixed with water at a ratio of one part AQUATAIN to 5.5 parts water. An application rate of approximately 3 gallons AQUATAIN, plus the required water, per 1000 square feet of surface area is normally required for most soil surfaces.

MEANS OF APPLICATION:

AQUATAIN can be applied with a hydroseeder along with seed and fertilizer. Equipment used for applying asphalt emulsions and water can also be used to apply AQUATAIN with little or no modification. For small areas, the chemical is generally applied with small hand operated sprayers.

CURING TIME:

No information available.

HANDLING LIMITATIONS:

None listed, but the chemicals are carried in water so the product must be stored in above freezing temperatures.

MANUFACTURER:

The Larutan Corporation
1424 South Allec Avenue
Anaheim, California 92805

NOTES

®CURASOL AE

Technical Information

DESCRIPTION:

®CURASOL AE is a milky-white, polyvinyl acetate copolymer emulsion. It is physiologically harmless and has no phytotoxic properties. The pH value is 4-5 and it is water dispersible.

OBJECTIVE:

Temporary Soil Stabilization - Temporarily binds surface soil in denuded areas in order to reduce water erosion.

Chemical Mulch - Partially binds surface soil in order to reduce erosion and evaporation losses and thereby favorably affect the development of a permanent vegetative cover. May be used in hydroseeder slurries as well as on preseeded areas.

Mulch Tack - Binds natural fiber mulches to reduce losses caused by wind and rain.

WHERE USED:

®CURASOL AE is used as a temporary soil stabilizer, mulch, and mulch tack on all types of soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

For use as a chemical mulch and/or soil stabilizer, the amounts of ®CURASOL AE and water generally required per acre of area are as follows:

Flat Areas - 30 gallons ®CURASOL AE to 1000 gallons of water for moist soil. For dry soil use 2000 gallons of water.

3:1 to 2:1 Slopes - 40 to 55 gallons ®CURASOL AE to 1000 gallons of water for moist soil. For dry soil use 2000 gallons of water.

1-1/2:1 Slopes - 55 to 65 gallons ®CURASOL AE to 1000 gallons of water for moist soil. For dry soil use 2000 gallons of water.

Swales and Ditches - 90 to 100 gallons ®CURASOL AE to 1000 gallons of water for moist soil. For dry soil use 2000 gallons of water.

MEANS OF APPLICATION:

®CURASOL AE can be applied with a hydroseeder along with the seed and fertilizer. Spraying equipment normally used for applying asphalt emulsions or water can also be used, with little or no modification, to apply the binder.

CURING TIME:

Curing time is dependent upon weather conditions, but is generally 2-6 hours after application.

HANDLING LIMITATIONS:

Will freeze at 23°F. Can be applied at temperatures above 34°F. Treated surfaces should be traffic free except when very high concentrations of material are used. May be sprayed on wet or dry soil. May be stored at least 6 months, but should not be stored in extreme heat, sunlight, or subfreezing conditions.

MANUFACTURER:

American Hoechst Corporation
1041 Route 202-206 North
Bridgewater, New Jersey 08876

NOTES

®CURASOL AH

Technical Information

DESCRIPTION:

®CURASOL AH is a milky-white, high-polymer synthetic resin dispersion. It is physiologically harmless and has no phytotoxic properties. The pH value is 4-5 and it is water dispersible.

OBJECTIVES:

Temporary Soil Stabilizer - Temporarily binds surface soil in denuded areas in order to reduce water erosion. Chemical specially designed for use under freeze-thaw conditions or when stabilized area is subject to some traffic.

Mulch Tack - Binds natural fiber mulches to reduce losses caused by wind and rain.

WHERE USED:

®CURASOL AH is used as a temporary soil stabilizer and mulch tack on all types of soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

Straw Mulch Tack - Under normal conditions, using a mulch blower, a mixture of 30 to 45 gallons of ®CURASOL AH and 150 to 300 gallons of water is generally required to tack one acre of mulch. A greater quantity of water, generally 300 to 500 gallons, is required when the tack is applied with a hydroseeder.

Hay Mulch Tack - a mixture of 20 to 30 gallons of ®CURASOL AH and 150 to 300 gallons of water is generally required for one acre of area when the tack is applied with a mulch blower. Using a hydroseeder, a greater quantity of water, generally 300 to 500 gallons, is required in the mixture.

MEANS OF APPLICATION:

®CURASOL AH can be applied with a mulch blower or hydroseeder and with sprayers normally used for applying asphalt emulsions or water.

CURING TIME:

Curing time is dependent upon weather conditions, but is generally 1-6 hours after application.

HANDLING LIMITATIONS:

Will freeze at 23°F. Can be applied at temperatures above 41°F. May be stored under normal conditions for at least six months. Should not be exposed to strong sunlight or heat. Must be protected from frost.

MANUFACTURER:

American Hoechst Corporation
1041 Route 202-206 North
Bridgewater, New Jersey 08876

NOTES

DCA-70

Technical Information

DESCRIPTION:

DCA-70 is a milky-white, viscous, water dispersible polyvinyl acetate emulsion. It is nonflammable, nontoxic, and nonphytotoxic. The pH ranges from 4 to 6.

OBJECTIVE:

Temporary Soil Stabilizer - On denuded areas it penetrates the soil and binds soil particles into a coherent mass that reduces erosion by water.

Chemical Mulch - Partially binds surface soil in order to reduce erosion and evaporation losses and thereby favorably affect the development of a permanent vegetative cover. May be used in hydroseeder slurries as well as on preseeded areas.

Mulch Tack - Binds natural fiber mulches to reduce losses caused by wind and rain.

WHERE USED:

DCA-70 is used as a temporary soil stabilizer, mulch, and mulch tack on all types of soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

Various dilution and application rates will depend on soil, slope, etc., conditions and the material should be applied in accordance with manufacturer's recommendations. However, general requirements are as follows:

Soil Stabilizer - Mix one part DCA-70 to one part clean water and apply 0.5 or more gallons per square yard.

Chemical Mulch - Mix one part DCA-70 to 20 or more parts of clean water and apply 0.5 gallon per square yard on permeable soils.

Mulch Tack - Mix one part DCA-70 to 10-20 parts water. Apply this solution at a rate sufficient to disperse 30-45 gallons of DCA-70 concentrate per acre.

MEANS OF APPLICATION:

Equipment used for applying asphalt emulsions and water can be used to apply DCA-70. Hydroseeders can also be used to apply the chemical with little or no modification.

CURING TIME:

DCA-70 cures in one hour at 90°F and two hours at 60°F and 50 percent relative humidity.

HANDLING LIMITATIONS:

Solids separation occurs in temperatures below 40°F.

MANUFACTURER:

Union Carbide Corporation
Chemicals and Plastics
270 Park Avenue
New York, New York 10017

NOTES

LIQUID ASPHALT

Technical Information

DESCRIPTION:

The basic component is asphalt cement. It is dispersed or suspended in water or various solvents.

OBJECTIVE:

Mulch Tack - Binds natural fiber mulches to reduce losses caused by wind and rain.

Chemical Mulch - Partially binds surface soil in order to reduce erosion and evaporation losses and thereby favorably affect the development of a permanent vegetative cover.

WHERE USED:

Liquid Asphalt is used as a mulch tack and chemical mulch on all types of soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

Chemical Mulch - Apply Liquid Asphalt or emulsified asphalt as a spray at the rate of 0.15-0.30 gallon per square yard, depending upon soil and slope conditions.

Mulch Tack - Apply Liquid Asphalt at a rate of 0.1 gallon per square yard and emulsified asphalt at a rate of 0.04 gallon per square yard.

MEANS OF APPLICATION:

Asphalt may be applied by hand-spray nozzle or with an offset distributor bar attached to an asphalt distributor truck.

CURING TIME:

Varies widely for various types of asphalt and weather conditions, but is generally 24 hours.

HANDLING LIMITATIONS:

Will adhere to shoes, etc., unless completely cured. Special care must be used when applying so that material will not drift beyond the area being mulched.

PRODUCT INFORMATION SERVICE:

The Asphalt Institute
Asphalt Institute Building
College Park, Maryland 20740

NOTES

PETROSET® SB

Technical Information

DESCRIPTION:

PETROSET® SB is a light tan colored oil in water emulsion of high strength rubber. It is free flowing and is water dispersible. The material is not flammable and is not toxic to humans or animals.

OBJECTIVE:

Temporary Soil Stabilization - On denuded areas it penetrates the soil and binds soil particles into a coherent mass that reduces erosion by water.

Chemical Mulch - On seeded areas it penetrates the soil and binds soil particles into a coherent mass. Water and air movement into the soil is maintained.

Mulch Tack - Binds natural and synthetic fiber mulches together and thereby reduces loss of mulch due to removal by wind and rain.

WHERE USED:

Used as a temporary soil stabilizer, mulch, and mulch tack on all types of soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

Numerous dilution ratios (i.e., parts of PETROSET®SB to parts of water) and application rates (also, spreading rates) have been developed by the manufacturer for different soil textures, desired penetrations, and intended usages. In general, the greater the dilution ratio (i.e., the greater the percentage of water) the deeper the penetration of the binder and the weaker the binding strength for a given soil condition. In addition, the finer the soil texture the greater the dilution ratio and application rate required to achieve a desired penetration. For example, in order to protect against normal rainwater and wind erosion and obtain a penetration of approximately 1/2 inch, a fine textured (fine grained) soil generally requires an application rate of one gallon dilute PETROSET®SB, having a dilution ratio of 1:14, per square yard. In order to achieve the same objective, a coarse textured soil generally requires an application rate of 0.4 gallon of dilute PETROSET®SB, having a dilution ratio of 1:5, per square yard. Specific application and cost formulas and nomographs are furnished by the manufacturer.

MEANS OF APPLICATION:

Practically any spraying equipment capable of delivering the desired quantity of dilute PETROSET®SB can be used. Distributor trucks with calibrated spreader bars, as well as hydroseeding equipment, are suitable for applying the chemical.

CURING TIME:

Thirty minutes after application this product has cured enough to perform satisfactorily and will not adhere to shoes.

HANDLING LIMITATIONS:

Will freeze, but freezing will not damage the product. Clean equipment should be used for application. Product contains some solvents and should therefore be kept away from children. Storage should be at temperatures of less than 150°F.

MANUFACTURER:

Phillips Petroleum Company
Chemical Department
Commerical Development Division
Bartlesville, Oklahoma 74003

NOTES

TERRA TACK

Technical Information

DESCRIPTION:

TERRA TACK is a highly concentrated, water dispersible chemical, marketed in powdered form which forms a thick green liquid when mixed with water.

OBJECTIVE:

Chemical Mulch - Partially binds surface soil in order to reduce erosion and evaporation losses and thereby favorably affect the development of a permanent vegetative cover. May be used in hydroseeder slurries as well as on preseeded areas.

Mulch Tack - Binds natural fiber mulches to reduce losses caused by wind and rain.

WHERE USED:

TERRA TACK is used as a chemical mulch and mulch tack on dry or porous soil surfaces.

GENERAL APPLICATION REQUIREMENTS:

For wet application in combination with seeding, an application rate of 50 pounds of TERRA TACK in 2000 gallons of water is recommended per acre. For dry application in combination with seeding, use 86 pounds per acre. When used as a mulch tack for long fiber mulches such as straw or hay, a mixture ratio of 1:20 parts water is recommended. This slurry should be applied at a rate of 1000 gallons per acre. For use with short fiber mulches like wood fiber mulch, a ratio of 1:40 is applied at a rate of 2000 gallons of slurry per acre.

MEANS OF APPLICATION:

Standard hydroseeding equipment used for applying seed, fertilizer, and certain mulches can be employed with little or no modification. For dry application, standard hopper spreaders used for applying fertilizers or lime can be utilized.

CURING TIME:

No specific curing information is available, but the manufacturer recommends application on dry soil at least two hours before sunset or rainfall.

HANDLING LIMITATIONS:

Avoid contact with skin and eyes. Avoid breathing dust or solution spray. Wash body thoroughly after using TERRA TACK. Tank life is limited to several hours, so use immediately after mixing.

MANUFACTURER:

Grass Growers, Inc.
P.O. Box 584
Plainfield, New Jersey 07061

NOTES

APPENDIX B

EROSION AND SEDIMENT CONTROL STRUCTURES

CHECK DAMS

DEFINITION:

A Check Dam is a structure used to stabilize the grade or to control head cutting in natural or artificial channels.

OBJECTIVE:

Check Dams are used to reduce or prevent excessive erosion by reduction of velocities in watercourses or by providing partial lined channel sections or structures that can withstand high flow velocities.

WHERE USED:

Check Dams are used where the capability of earth and/or vegetative measures is exceeded in the safe handling of water at permissible velocities, where excessive grade or overfall conditions occur, or where water is to be lowered from one elevation to another.

CONSTRUCTION RECOMMENDATIONS:

Formal design is generally required.

a. Overfall structures of concrete, metal, rock, gabions, Fabriform®, wood, etc., may be used in the construction of check dams.

b. The structure should be located in a reasonably straight channel section and particular attention must be given to the effect that new water levels will have on existing natural and man-made features.

c. Site and foundation conditions and aesthetic considerations are important factors in construction material selection.

d. Design channel grade above and below the structure should be analyzed to determine if erosion or sediment deposition will be a problem.

MAINTENANCE:

Generally not required.

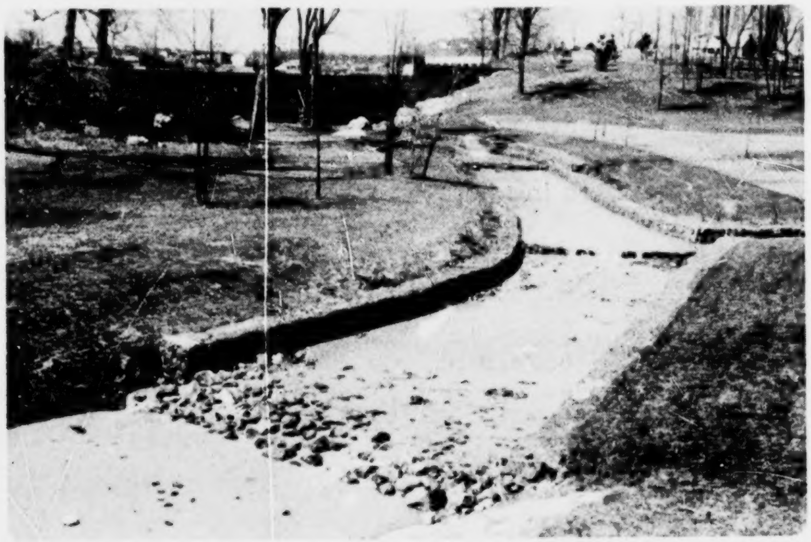


FIGURE B-1. Check Dams constructed of gabions and rock riprap

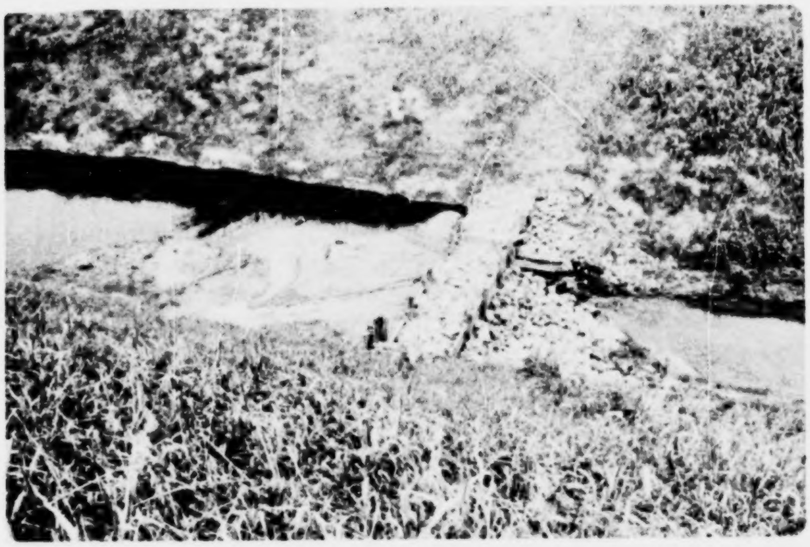


FIGURE B-2. Rock and wood check dam

NOTES

CHUTES/FLUMES

Technical Information

DEFINITION:

Chutes/Flumes are channels of concrete or comparable material that is designed to conduct runoff downslope.

OBJECTIVE:

Chutes/Flumes conduct storm runoff from one elevation to another without erosion of the slope.

WHERE USED:

Chutes/Flumes are used as temporary, interim, or permanent structures down slopes where concentrated runoff would cause slope erosion.

CONSTRUCTION RECOMMENDATIONS:

Formal design guidance is usually required to properly size the proposed structure.

Placement - On undisturbed soil or well compacted fill.

Slope - No steeper than 1.5:1 (horizontal to vertical) nor flatter than 20:1.

Elevation - Top of the lining of the inlet structure must not be higher in elevation than the lowest top elevation of training beams or other devices that direct overland flow to the chute or flume.

Outlet Protection - Some form of energy dissipating device should be incorporated into the outlet structure at the toe of the slope.

Entrance Structure - Shall slope toward the outlet at 0.25 to 1.2 inches per foot.

Compaction - Insure that a good bond is attained at the interface of the structure and training berms.

Outlet - To stabilized area.

MAINTENANCE:

Inspect for damage after each storm if the structure is of a temporary or interim nature. Inspect for signs of piping failure at interface of entrance structure and training berms.

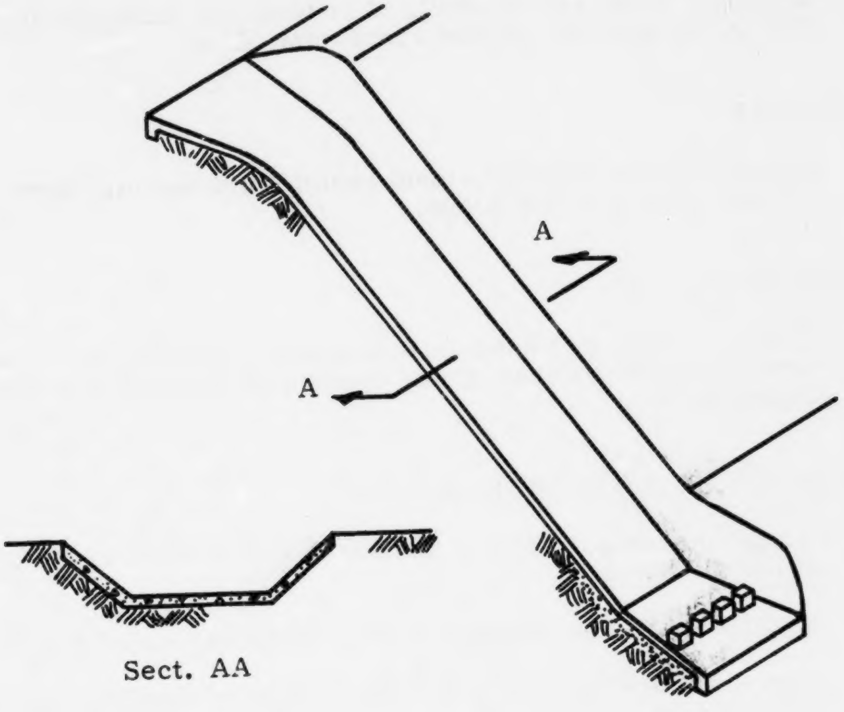


FIGURE B-3. Chute/flume

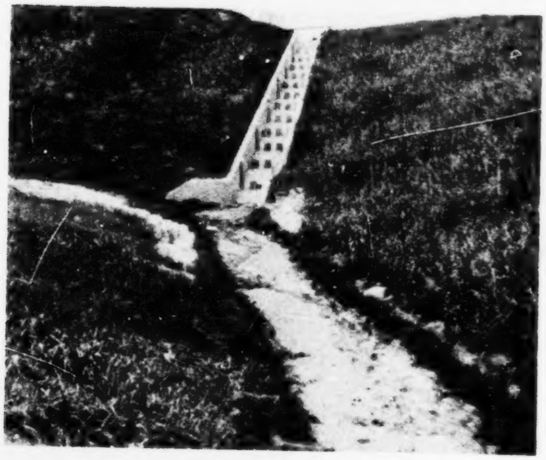


FIGURE B-4. Flume with energy dissipators

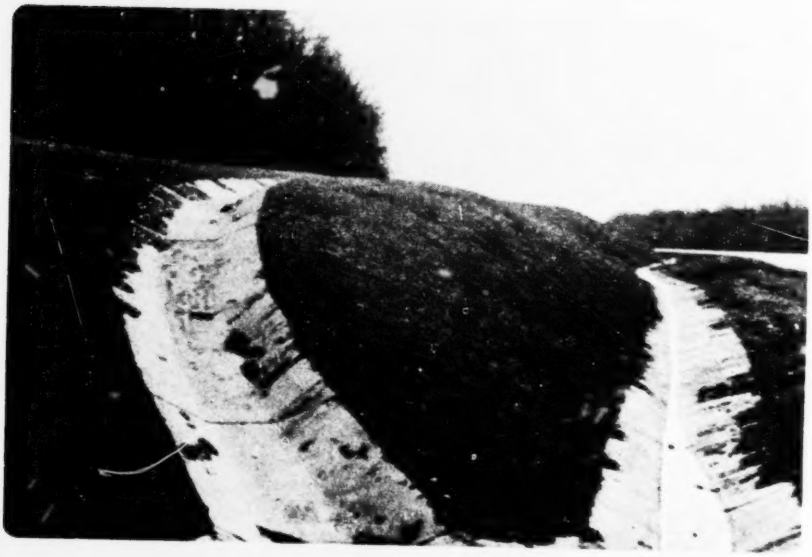


FIGURE B-5. Concrete chute

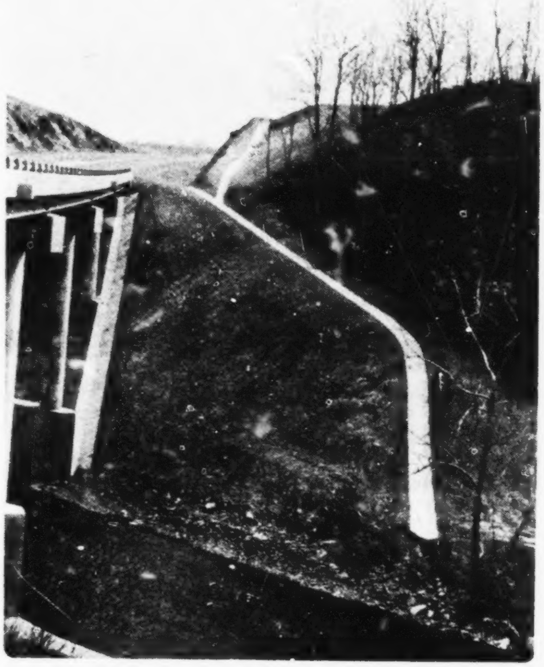


FIGURE B-6. Concrete chute

NOTES:

DIVERSION DIKE

Technical Information

DEFINITION:

A Diversion Dike is a temporary ridge of soil constructed at the top of cut or fill slopes.

OBJECTIVE:

Diversion Dikes divert overland flow from small areas away from unstabilized slopes.

WHERE USED:

Diversion Dikes are used as a temporary or interim measure at the top of a newly constructed slope.

CONSTRUCTION RECOMMENDATIONS:

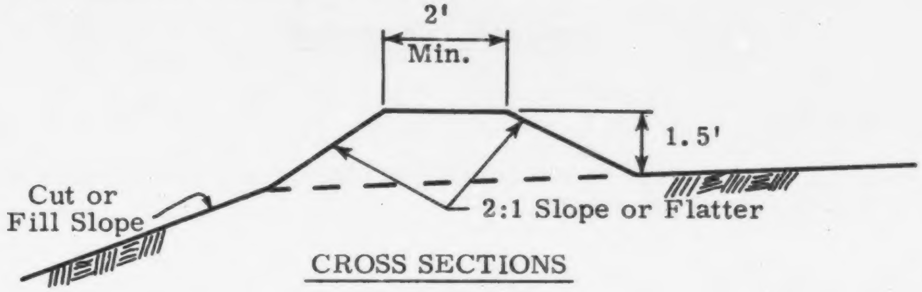
Formal design often not required.

General criteria include:

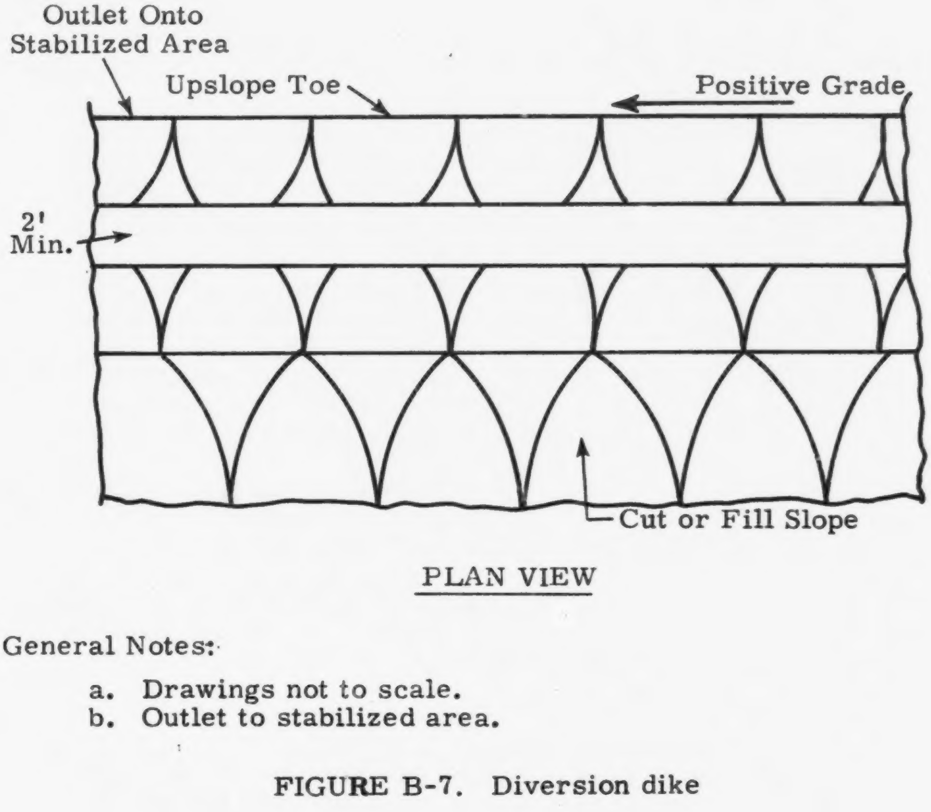
Height:	1.5 feet
Top Width:	2 feet
Side Slopes	2:1 or flatter
Compaction:	Should be 85 percent standard density
Grade:	Dependent upon topography - must be positive. Excessive grades may require additional stabilization in flow area.
Other:	In wooded areas where top of slope access is limited, diversion dikes can be constructed as a dozer finishes the slope by carrying soil upslope and dumping it at crest. Compaction is sacrificed in this instance.

MAINTENANCE:

Inspect after each rain to locate any damaged areas. Repair must be completed before next storm to ensure against the outlet of concentrated flow to the surface of the bare slope. Any channel obstructions should be removed.


2'
Min.
1.5'
Cut or
Fill Slope
2:1 Slope or Flatter

CROSS SECTIONS


Outlet Onto
Stabilized Area
Upslope Toe
Positive Grade
2'
Min.
Cut or Fill Slope

PLAN VIEW

General Notes:

a. Drawings not to scale.
b. Outlet to stabilized area.

FIGURE B-7. Diversion dike

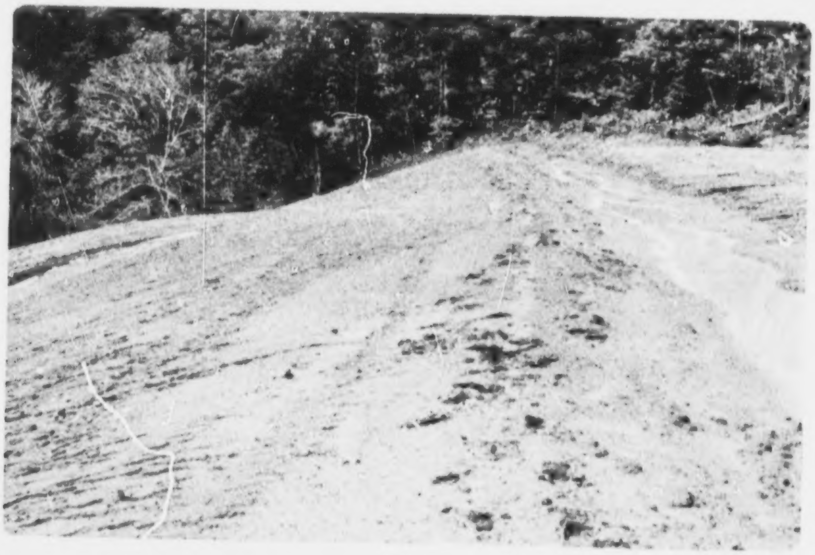


FIGURE B-8. Diversion dike at top of slope

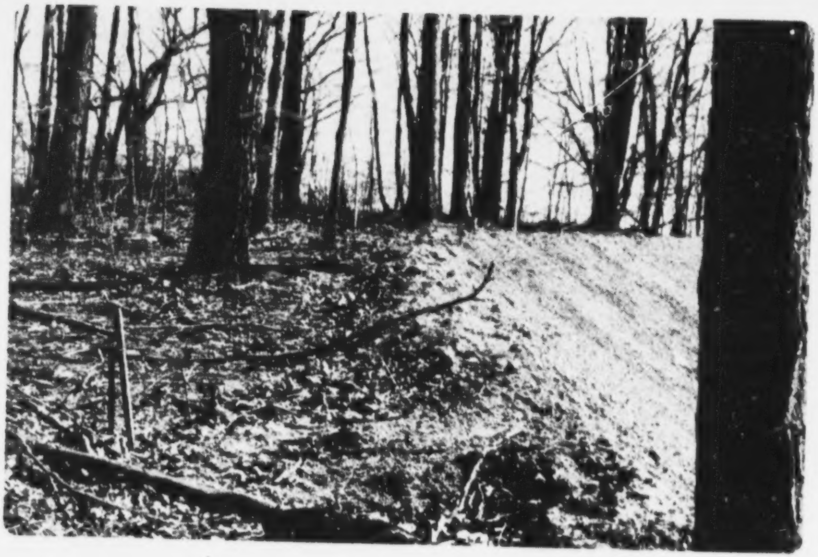


FIGURE B-9. Diversion dike constructed by dozer moving soil upslope and dumping at top of slope

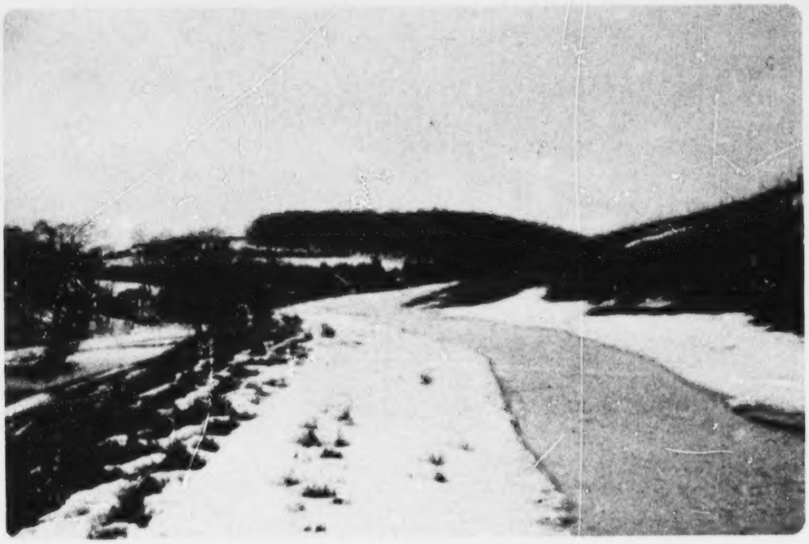


FIGURE B-10. Diversion on a stabilized slope

NOTES:

EROSION CHECK

Technical Information

DEFINITION:

Erosion Checks comprise a technique whereby porous, mat-like material is installed in a slit trench that is oriented perpendicular to the direction of flow in a ditch or swale. It prevents the formation of rills and gullies by permitting subsurface water migration without the removal of soil particles.

OBJECTIVE:

The nonerodible erosion check prevents the formation of rills and gullies by permitting subsurface water migration without the removal of soil particles and by providing positive grade control of surface flow.

WHERE USED:

Erosion Checks are used at predetermined intervals across the center line of ditches and swales in which vegetative cover is being established. They can be used on critical slopes where severe sheetflow problems may occur.

CONSTRUCTION RECOMMENDATIONS:

See Figure B-11.

Material - Flexible, porous, long lived mats or membranes of fiber glass, plastic, etc.

Location in ditch or swale

(1) Immediately downstream from every tributary discharge point.

(2) At each point of change in gradient (steep to shallow and shallow to steep).

(3) Remaining channel: 20-75 foot centers depending upon slope, soil type and condition, etc. Solicit guidance from local conservationists experienced with this technique.

Depth - The bottom of the erosion check shall be installed at least three inches below the maximum depth at any existing rill or gully and 8-12 inches deep in newly graded areas.

Lateral Extent - Must be carried to an elevation at least 6 inches above the design flow elevation to protect against rill formation during intense runoff events.

Anchoring - Staple material to bottom of trench and to vertical side of slit trench on 24 inch centers.

Backfilling - Slit trench must be backfilled and carefully compacted after erosion check has been installed. Trim flush with soil surface. Reseed area disturbed by erosion check construction.

Cap strip - Any conventional mat or blanket material used in the establishment of vegetation in swales or ditches can be used (Appendix C). The cap strip should extend about 2 feet to each side (upstream and downstream) of the erosion check and is applied in addition to any other mulching material used for vegetative establishment. It should be stagger stapled on 6-9 inch centers along the erosion check. Conventional staple configuration can be used on the remainder of the cap strip.

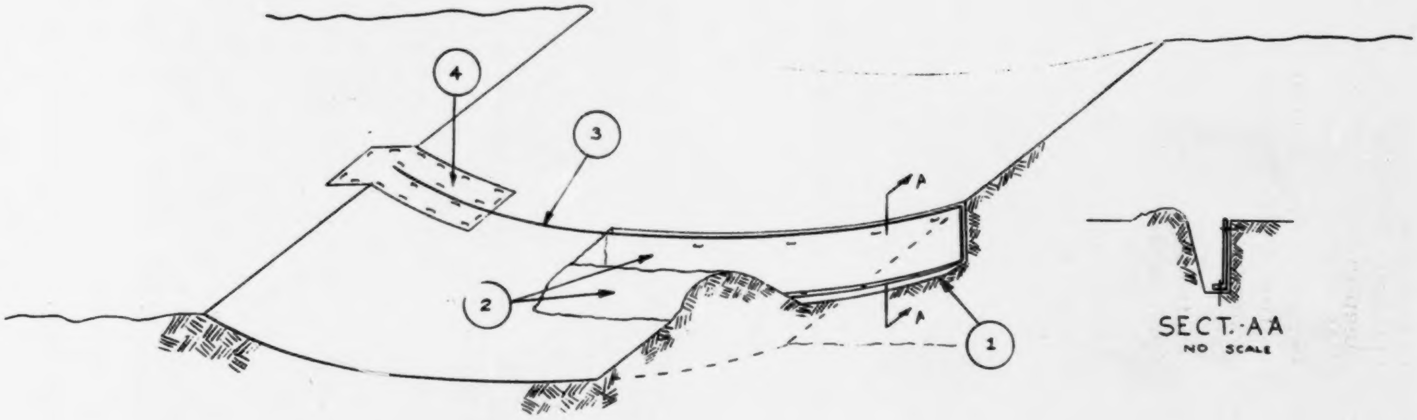
Timing - Install immediately after final grading and/or seedbed preparation.

MAINTENANCE:

Inspect for erosion damage and replace or repair as necessary. Maintain a strong, healthy vegetative stand by regular fertilization.

GENERAL NOTES:

A combination of short, warm season grasses and nondegradable nettings of plastic and fiber glass have been used successfully as a modification of the cap strip. The dense root mat of the warm season grass and the strength provided by the netting in addition to the erosion check have given superior performance in the control of rill and gully formation in swales and ditches. The spreading of the warm season grass can be controlled by using taller grasses to surround the cap strip area. The shade provided by a 6-inch stand of grass will discourage the spreading of the warm season grass.



1. Cutaway of fiber glass installation in bottom of trench.
2. Cutaway of fiber glass installation in trench with spoil pile.
3. Trench with fiber glass erosion check installed.
4. Cap strip of blanketing material over completed erosion check.

FIGURE B-11. Erosion check

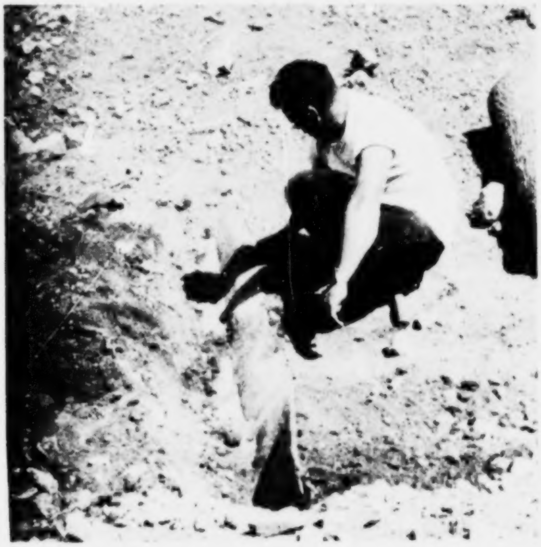


FIGURE B-12. Fiber glass erosion check in trench - awaiting backfill

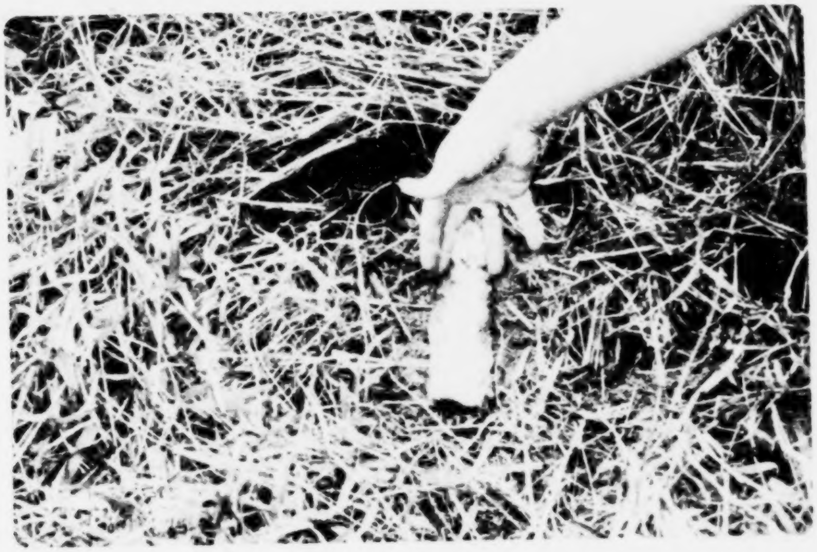


FIGURE B-13. Fiber glass erosion check and well-established vegetation

NOTES

FABRIFORM® EROSION CONTROL MATS

DEFINITION:

The Fabriform® process is a technique for pressure injecting fluid mortar into flexible fabric forms.

OBJECTIVE:

Fabriform® mats provide structure, slope, and grade protection, both above and below the waterline.

WHERE USED:

Fabriform® mats are used in shoreline stabilization, levee facing, channel lining, and the construction of revetments and check dams.

Material type - Filter point mats are designed to relieve hydrostatic uplift pressures. They also tend to articulate along the lines of the filter points to minimize undercutting. Flow-alteration characteristics of the cobble like surface of Filter Point mats make them effective in slowing water velocity in fast streams and at outfall installations.

Uniform Cross Section mats are recommended for installation where the primary objective is impermeability and low hydraulic friction.

CONSTRUCTION RECOMMENDATIONS:

Formal design required.

Utmost care must be exercised to ensure that toe trenches are designed and constructed at elevations and in such manner that will not allow undercutting. The following information is presented to show, by example, the procedure followed in the installation of a typical revetment. It is for information purposes only and design and construction guidance on specific projects should be secured from professionals familiar with the use of Fabriform® mats.

a. Remove stumps, boulders, and brush from the site. Grade sufficiently to provide a slope which is stable in the absence of erosive forces. In general, an average slope steeper than 1:1 is not recommended. Cut an upper toe trench to prevent undercutting of the mat in event of heavy runoff.

b. Beginning upstream, prefabricated fabric panels, usually from 2000 to 3000 square feet each in area, are placed over the embankment with seams straight and preferably perpendicular to the shoreline. The flexible, lightweight nylon fabric is usually placed by hand. Guide ropes to the opposite shore or small boats may also be used to assist in fabric placement.

c. Fabric panels as delivered to the job are field-sewn together with heavy nylon thread to create a monolithic structure of any required length and width. Seams are sewn in the field with a portable air-operated or electric bag closer.

d. Ready mix mortar is injected into the fabric envelope with a mortar pump, usually having a capacity of from 10 to 12 cubic yards per hour. The fabric in the toe trench is pumped first to serve as an anchoring and positioning function. Next, the undercut portion of the mat is pumped followed by filling the remaining section of the fabric. Production rates as high as 1000 square feet per man per day have been achieved on large projects.

e. The toe trench at the top of the mat is then backfilled.

MAINTENANCE:

Periodic inspection for signs of undercutting or excessive erosion at transition areas.

MANUACTURER:

Construction Techniques, Inc.
1111 Superior Building
Cleveland, Ohio 44114

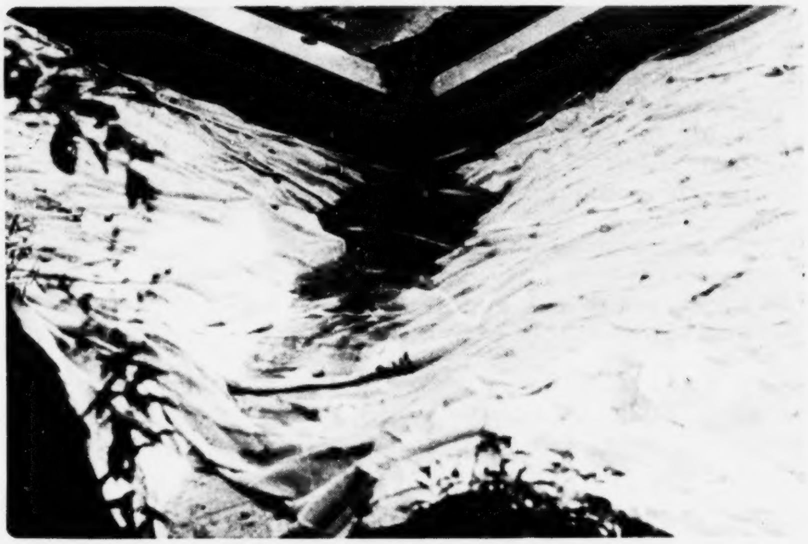


FIGURE B-14. Fabriform® mat in place - awaiting filling

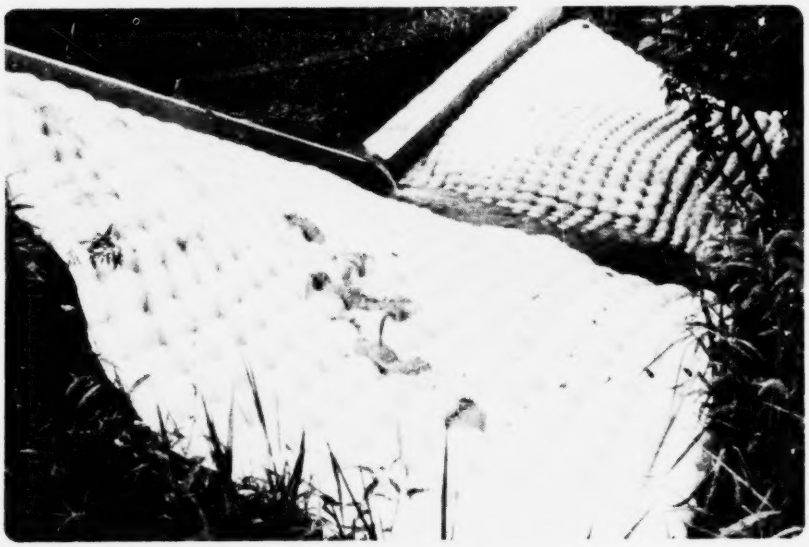


FIGURE B-15. Completed Fabriform® (filterpoint) structure

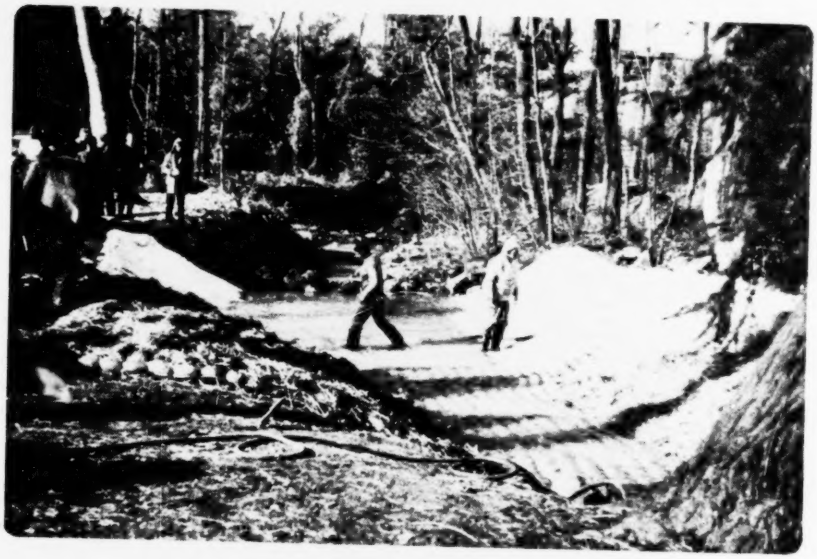


FIGURE B-16. Fabriform® channel lining being filled

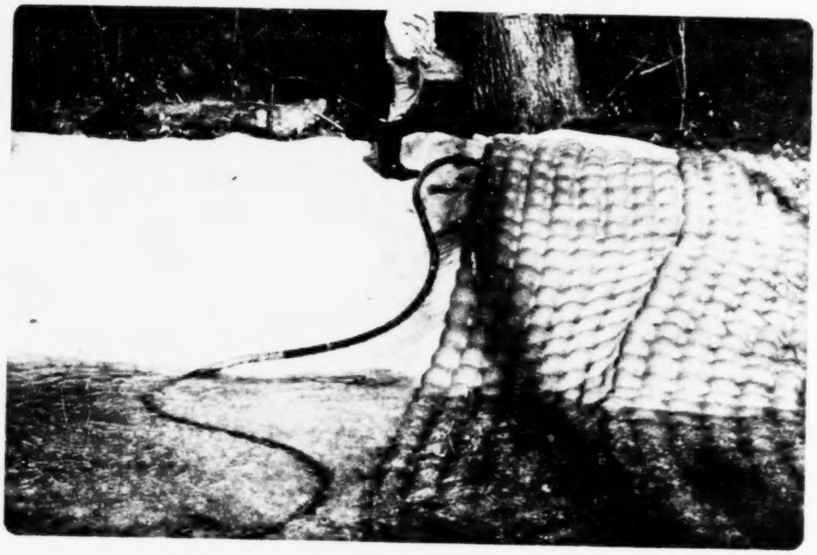


FIGURE B-17. Fabriform® channel lining being filled
Note uninterrupted stream flow.

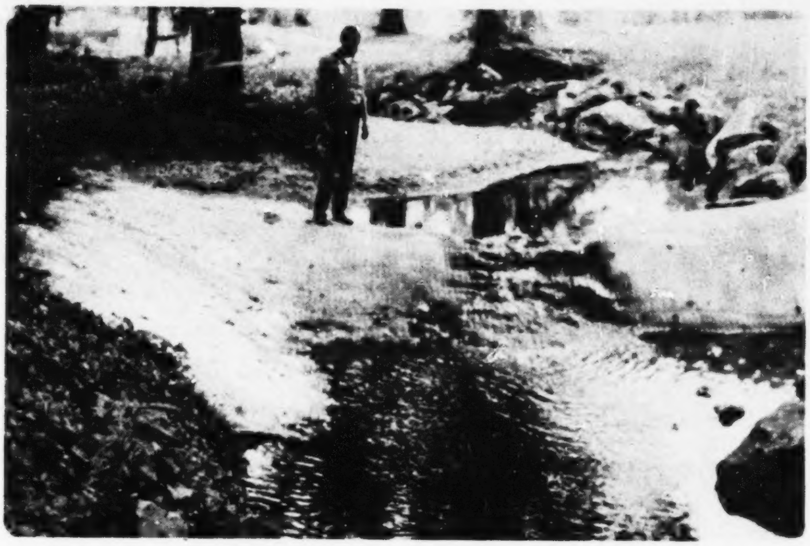


FIGURE B-18. Fabriform® (uniform cross section) check dam

NOTES:

FILTER BERM

Technical Information

DEFINITION:

A Filter Berm is a temporary ridge of gravel or crushed rock constructed across a graded right-of-way.

OBJECTIVE:

Filter Berms retain sediment on-site by retarding and filtering runoff while at the same time allowing construction traffic to proceed along the right-of-way.

WHERE USED:

Filter Berms are used primarily across graded rights-of-way that are subject to vehicular traffic. Also applicable for use in drainage ditches prior to roadway paving and establishment of permanent ground cover.

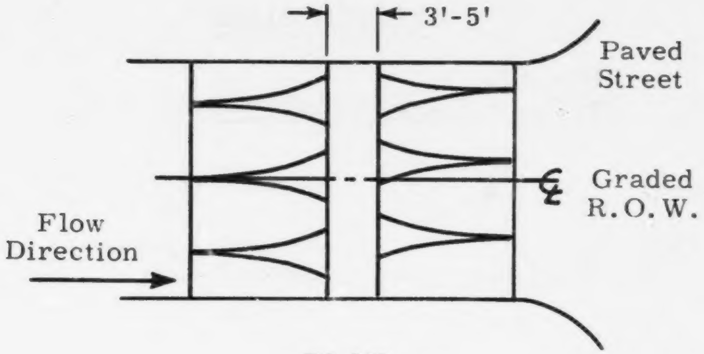
CONSTRUCTION RECOMMENDATIONS:

Formal design not required. Minimum requirements for use on graded rights-of-way are generally as follows:

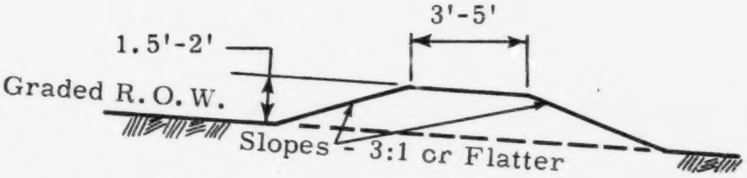
Height:	1.5-2 feet (uniform top elevation)
Top Width:	3-5 feet
Side Slopes:	3:1 or flatter
Spacing:	200-300 feet (steeper slopes require closer spacing)
Material:	Coarse (3/4"-3"), well graded gravel or crushed rock. Fines less than 5 percent.

MAINTENANCE:

Removal of trapped sediment and cleanout or replacement of clogged filter material after each storm.


3'-5'
Paved Street
℄
Graded R.O.W.
Flow Direction

PLAN


3'-5'
1.5'-2'
Graded R.O.W.
Slopes - 3:1 or Flatter

SECTION

GENERAL NOTES:

a. Drawings not to scale.
b. Top width may be widened; slopes may be flattened.
c. Outlet should function with minimal erosion. Outlet availability should be considered in structure location. A temporary grade stabilization structure is required where outlet is to a critical area.

FIGURE B-19. Filter berm

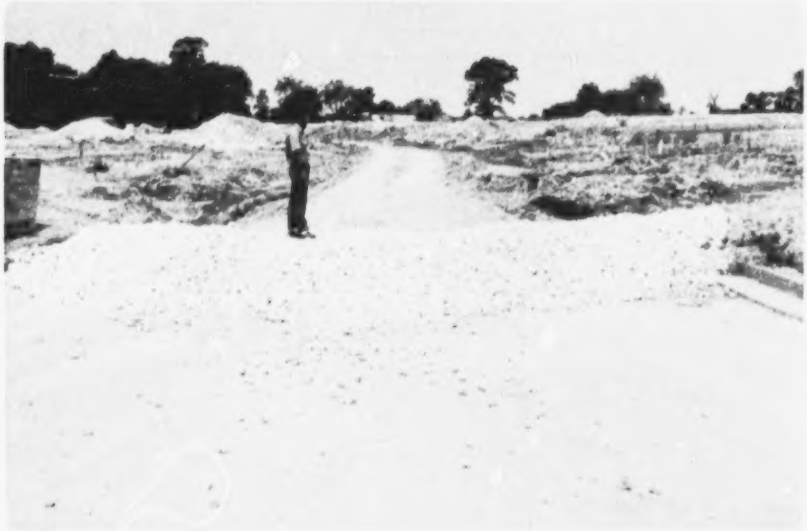


FIGURE B-20. Filter berm - installed

FIGURE B-21. Filter berm - installed

NOTES

FILTER INLET

Technical Information

DEFINITION:

A Filter Inlet is a temporary filter of gravel or crushed rock constructed at storm sewer curb inlet structures.

OBJECTIVE:

Filter Inlets retain sediment on-site by slightly retarding and filtering storm runoff before it enters the storm sewer system.

WHERE USED:

Filter Inlets are used at storm sewer curb inlets.

CONSTRUCTION RECOMMENDATIONS:

Formal design not required.

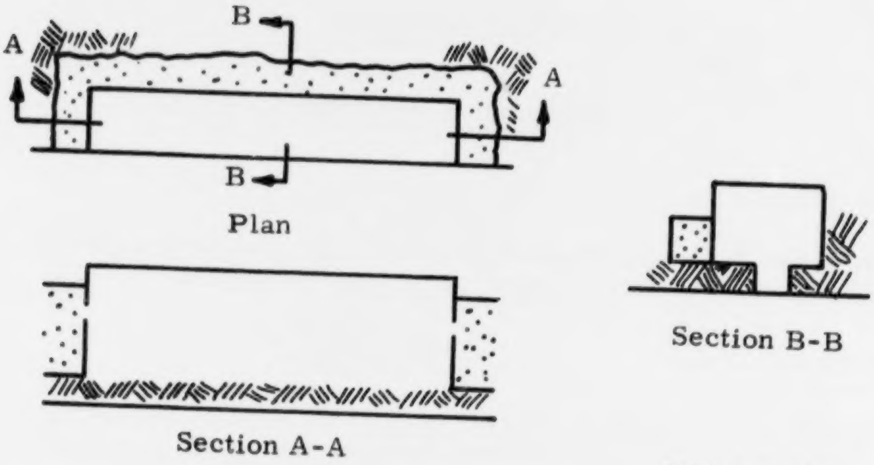
a. Several different design concepts are in use. One utilizes concrete building blocks in the throat of the inlet. The filter material is then placed between the blocks and the street in the gutter section.

b. A second concept does not use concrete blocks. A ridge of filter material is built around the inlet throat. It is kept out of the storm sewer by boards across the throat; the filter material is about half as deep as the inlet opening. Large volumes of water flow over the top of this filter inlet.

c. All filter material should be coarse (3/4"-3"), well graded gravel or crushed rock. Fines should be less than 5 percent.

MAINTENANCE:

Remove trapped sediment and clean out or replace clogged filter material after each storm.


B
A
A
B
Plan
Section A-A
Section B-B

Not to scale.

FIGURE B-22. Filter inlet

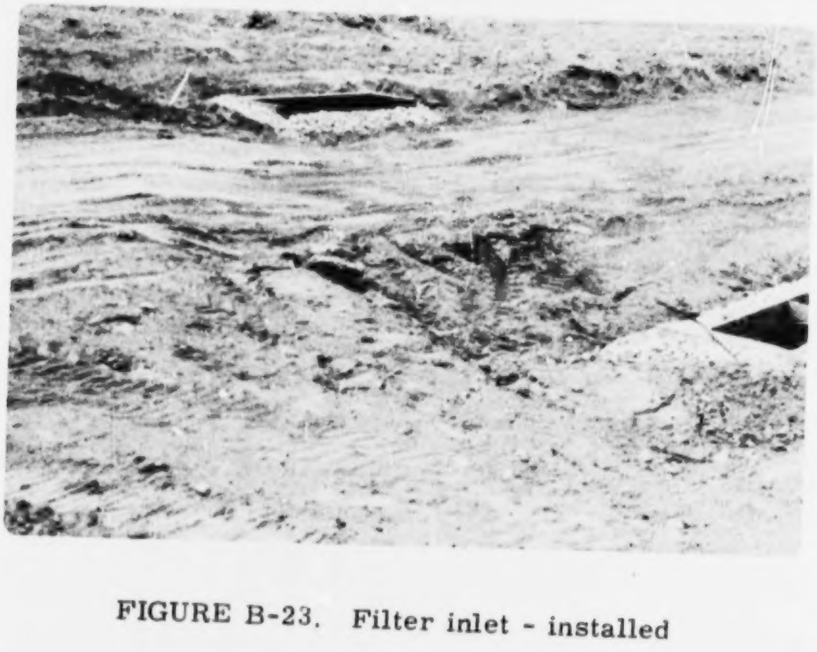


FIGURE B-23. Filter inlet - installed

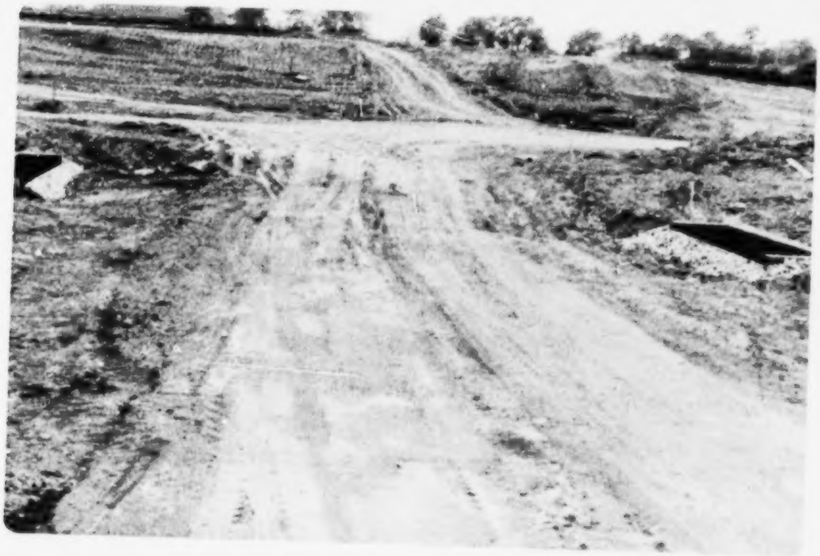


FIGURE B-24. Filter inlets - installed

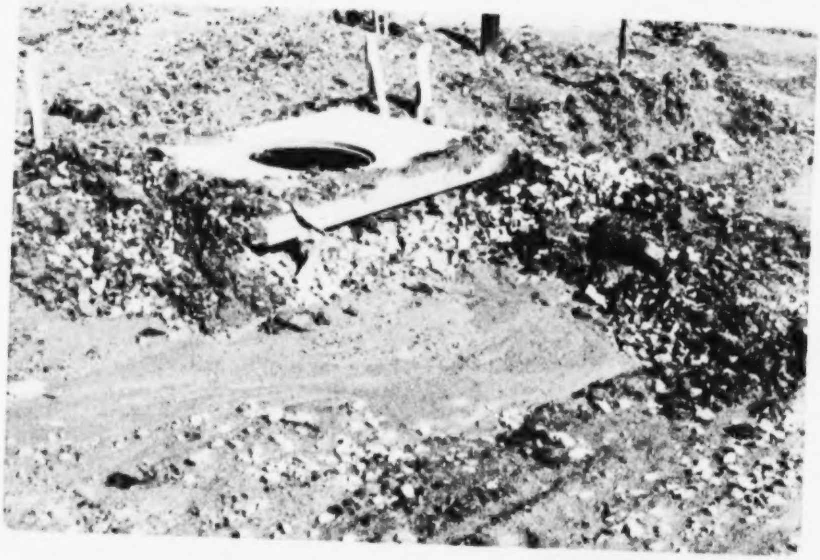
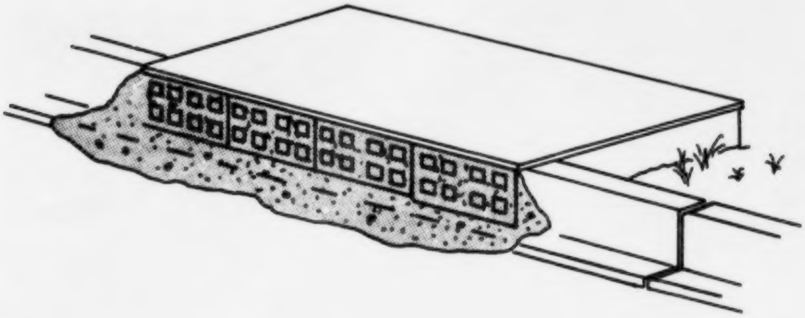
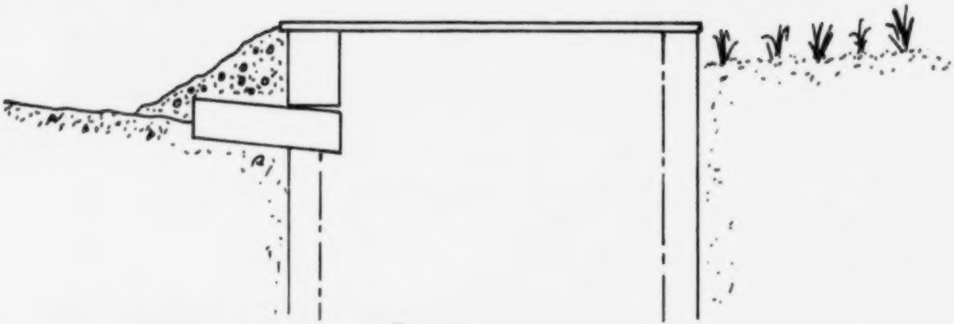


FIGURE B-25. Filter inlet requiring maintenance



Isometric



Section

FIGURE B-26. Filter inlet

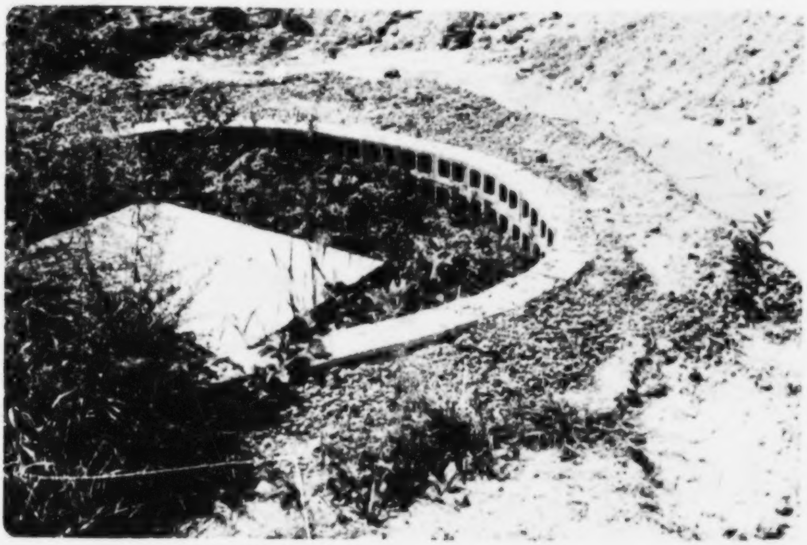


FIGURE B-27. Filter inlet - installed

NOTES

FLEXIBLE DOWNDRAIN

Technical Information

DEFINITION:

A Flexible Downdrain is a flexible conduit of heavy duty fabric or other material.

OBJECTIVE:

Flexible Downdrains conduct storm runoff from one elevation to another without erosion of the slope.

WHERE USED:

Flexible Downdrains are used as a temporary or interim structure down slopes where concentrated runoff would cause excessive slope erosion.

CONSTRUCTION RECOMMENDATIONS:

Formal design not required.

Placement - On undisturbed soil or well compacted fill.

Diameter - Sufficient to convey maximum runoff expected during the life of the drain.

End Sections - Standard metal. Entrance section should slope toward outlet at rate of at least 1/2" per foot. Soil should be carefully placed and compacted around entrance section to ensure against piping failure along end section and extension collar.

Extension Collars - 12" long, corrugated metal pipe. DO NOT USE HELICAL PIPE.

Securing Straps - Fabric, metal, etc., secured in at least one corrugation of extension collar.

Anchors - Metal "T" pins anchored in soil through grommets attached to the flexible downdrain. 20 foot centers.

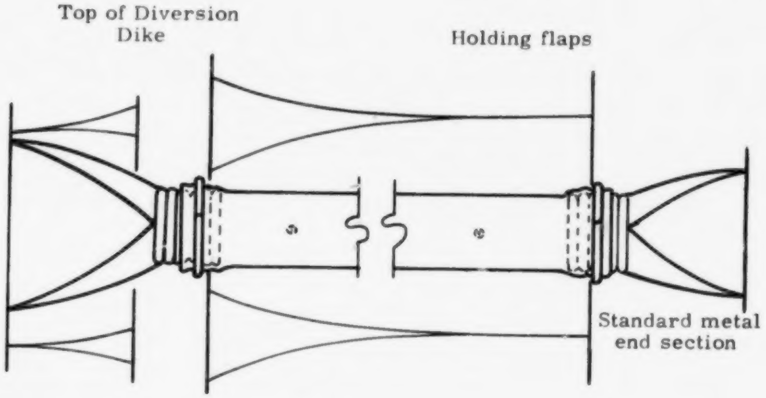
Outlet - To stabilized area wherever possible.

MAINTENANCE:

Inspect for clogging or damage after each storm. In below freezing weather, check to ensure that sides of collapsed downdrain are not frozen together. Do not allow placement of any material on collapsed downdrain. Inlet section should be checked for indications of piping along metal sections. Anchors should be resecured as necessary.

MANUFACTURER:

Reliance Plastic and Chemical Corporation
110 Kearney Street
P. O. Box 2627
Paterson, New Jersey 02509


Top of Diversion Dike
Holding flaps
Standard metal end section

PLAN VIEW

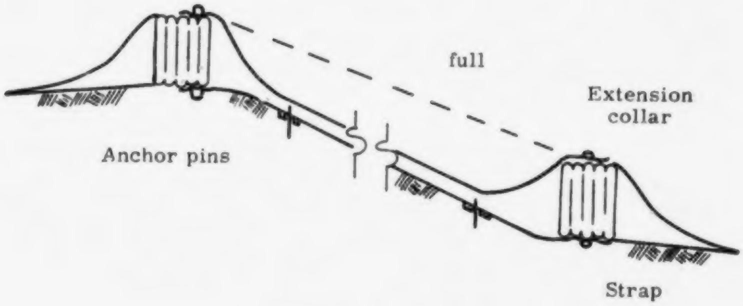

full
Extension collar
Anchor pins
Strap

FIGURE B-28. Flexible downdrain

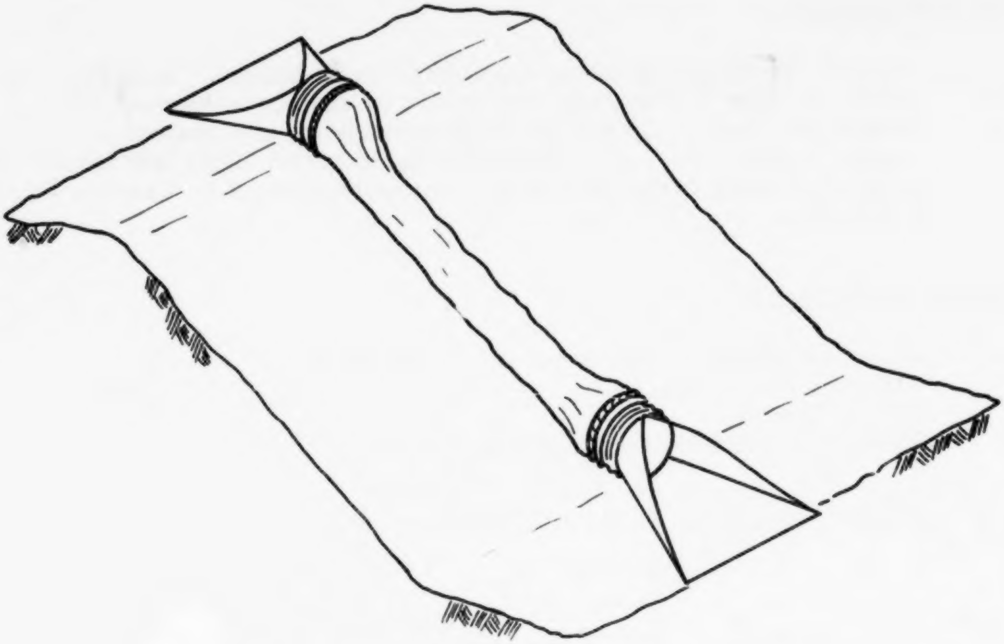


FIGURE B-29. Flexible downdrain - isometric

FIGURE B-30. Flexible downdrain - installed

FIGURE B-31. Flexible downdrain inlet structure

NOTES:

GABIONS

Technical Information

DEFINTION:

Gabions are large, multi-celled, rectangular wire mesh boxes.

OBJECTIVE:

Rock filled baskets, properly wired together, form flexible monolithic building blocks used for construction of erosion control structures.

WHERE USED:

Gabions are used in channels, revetments, retaining walls, abutments, check dams, etc.

CONSTRUCTION RECOMMENDATIONS:

Formal design required. Construction plans and drawings should be prepared by professionals familiar with the use of gabions. Erosion and sediment control construction design should ensure that foundations are properly prepared to receive gabions, that the gabion structure is securely "keyed" into the foundation and abutment surfaces, and that rock used is durable and adequately sized to be retained in the baskets.

MAINTENANCE:

Periodic inspection for signs of undercutting or excessive erosion at transition areas.

MANUFACTURER OR SUPPLIER:

Bekaert Steel Wire Corporation
Terra Aqua Conservation Division
4930 Energy Way
Reno, Nevada 89502

Maccaferri Gabions of America, Inc.
55 West 42nd Street
New York, New York 10026

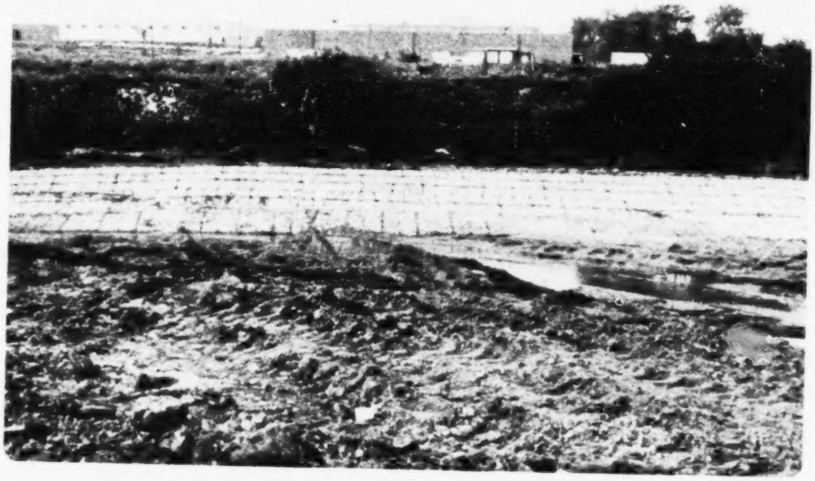


FIGURE B-32. Gabions - channel bank protection

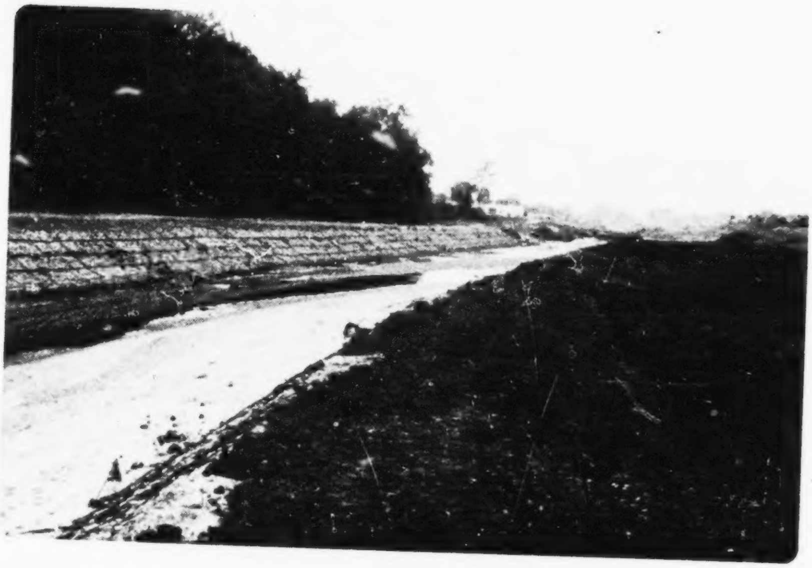


FIGURE B-33. Gabions - channel bank protection

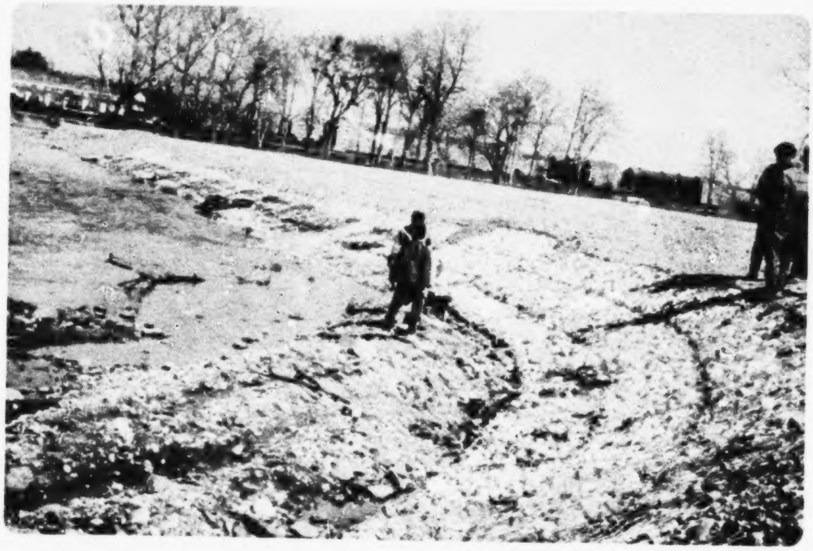


FIGURE B-34. Gabions - protection at stream bend

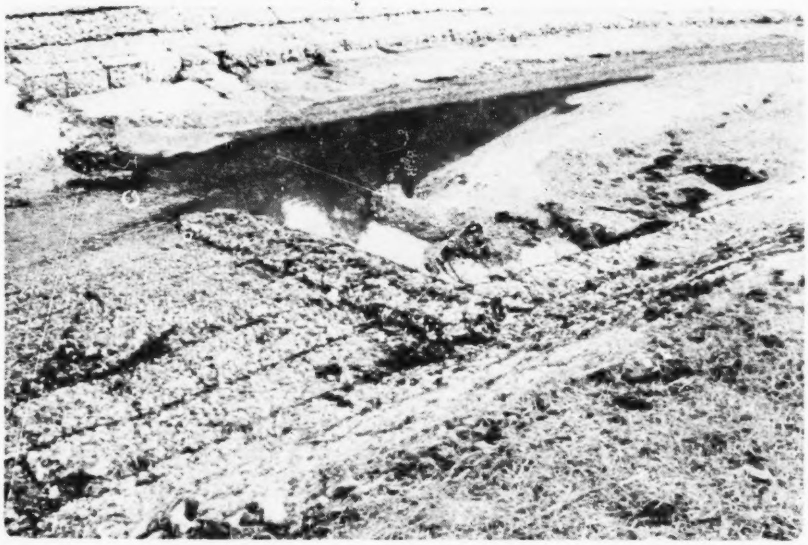


FIGURE B-35. Gabions - channel lining, check dam, and bank protection

NOTES

INTERCEPTOR DIKE

Technical Information

DEFINITION:

An Interceptor Dike is a temporary ridge of compacted soil constructed across a graded right-of-way.

OBJECTIVE:

Interceptor Dikes reduce erosion by intercepting storm runoff and diverting it to temporary outlets where it can be disposed of with minimal erosion.

WHERE USED:

Interceptor Dikes are used across graded rights-of-way that are not subject to vehicular traffic.

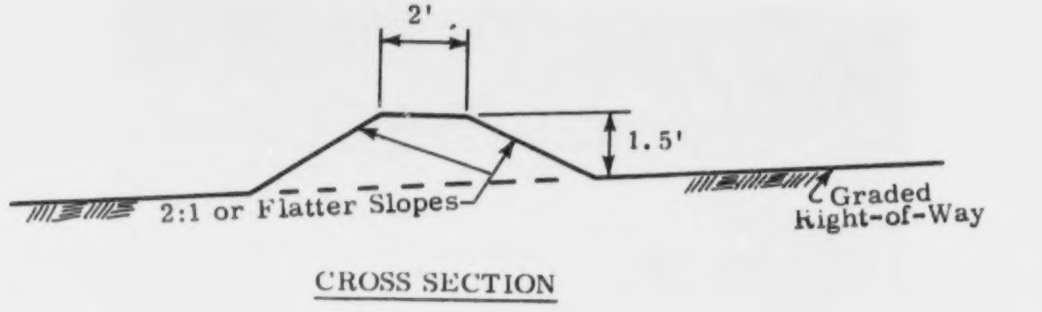
CONSTRUCTION RECOMMENDATIONS:

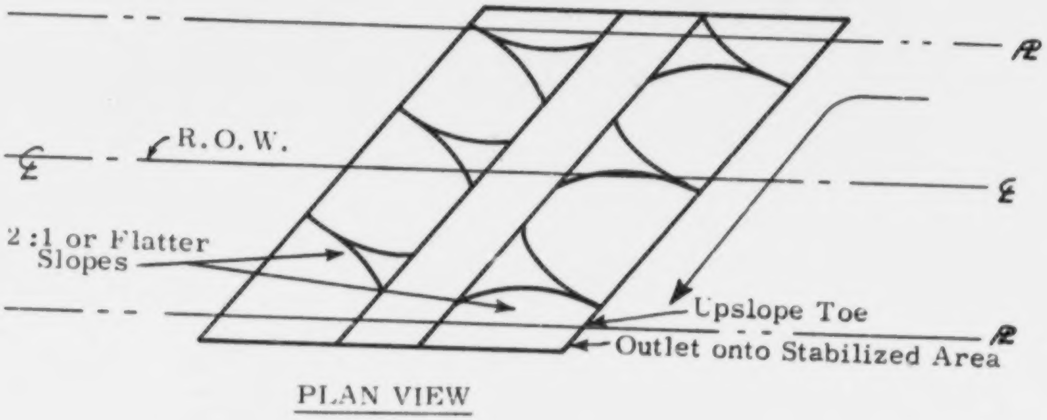
Formal design often not required. Minimum requirements for use on graded rights-of-way are generally as follows:

Height:	1.5 feet
Top Width:	2 feet
Side Slopes:	2:1 or flatter
Spacing:	200-300 feet (Steeper slopes require closer spacing.)
Material:	Compacted soil

MAINTENANCE:

Inspect after each rain to locate any damaged areas. Repairs must be completed before next storm to ensure against structural failure.


2'
1.5'
2:1 or Flatter Slopes
Graded Right-of-Way
CROSS SECTION


R.O.W.
℄
℄
℄
℄
2:1 or Flatter Slopes
Upslope Toe
Outlet onto Stabilized Area
PLAN VIEW

GENERAL NOTES:

a. Drawings not to scale.
b. Top width may be widened, slopes may be flattened.
c. Outlet should function with minimal erosion.

FIGURE B-36. Interceptor dike

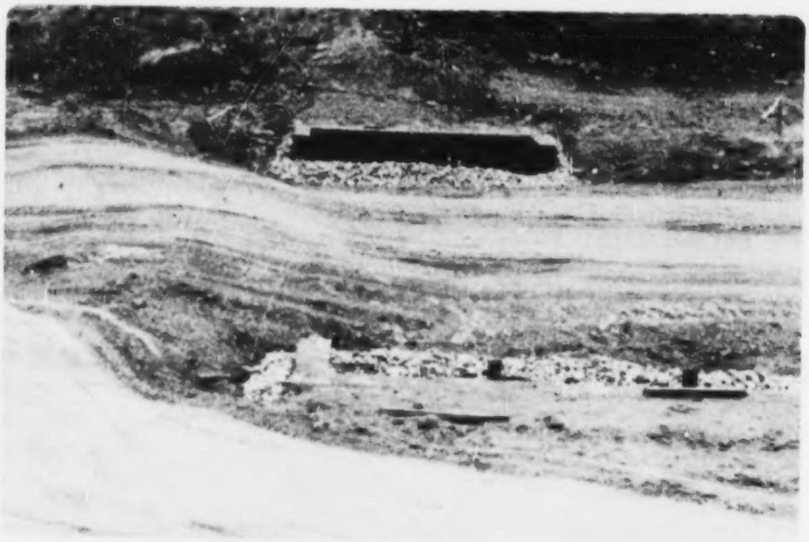


FIGURE B-37. Interceptor dike - installed and outletting to storm sewer inlets

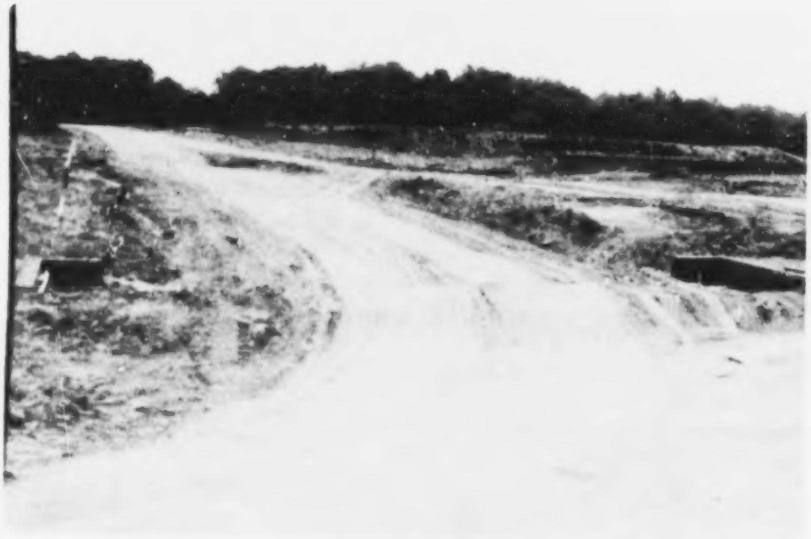


FIGURE B-38. Interceptor dike - installed

NOTES

LEVEL SPREADER

Technical Information

DEFINITION:

A Level Spreader is an outlet constructed at zero grade across a slope where concentrated runoff may be spread at nonerosive velocities over undisturbed areas stabilized by existing vegetation.

OBJECTIVE:

Level Spreaders convert concentrated flow into sheet flow for outlet at nonerosive velocities onto areas stabilized by vegetation.

WHERE USED:

Level Spreaders are used at locations where concentrated runoff from unstabilized areas can be diverted onto stabilized areas under sheet flow conditions.

CONSTRUCTION RECOMMENDATIONS:

Formal design is often not required, but extreme care must be used during construction to ensure that outlet lip is exactly level and uniform from end to end. Failure to meet these requirements will cause concentrated flow and consequent erosion of the stabilized area.

Depth below level lip: at least 0.5 ft

Length:

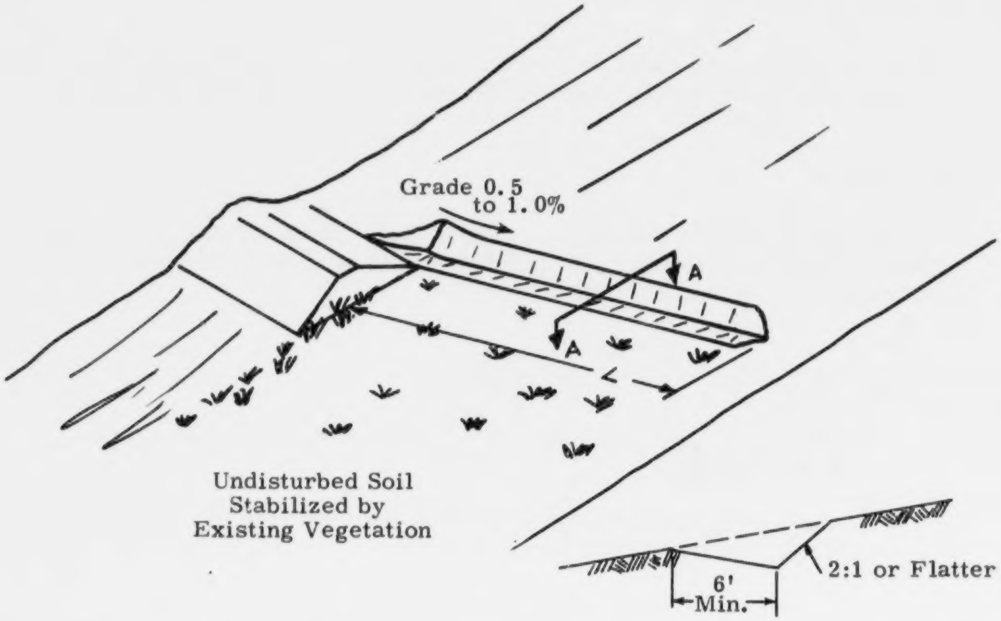
Flow (cfs)	Minimum Length (in feet)
up to 10	15
10-20	20
21-30	26
31-40	36
41-50	44

Width: at least 6 feet from center line to level lip

Back Slope:	2:1 or flatter
Material:	Must be constructed in undisturbed soil and must outlet onto an area stabilized with vegetation.

MAINTENANCE:

Inspect for damage after each storm. Repair as required.


Grade 0.5 to 1.0%
A
A
L
Undisturbed Soil Stabilized by Existing Vegetation
6' Min.
2:1 or Flatter

Drawing not to scale.

FIGURE B-39. Level spreader

NOTES

SANDBAG SEDIMENT BARRIERS

Technical Information

DEFINITION:

Sandbag Sediment Barriers are temporary barriers or diversions that are constructed of sandbags.

OBJECTIVE:

The barriers are built to retain sediment on-site by slowing storm runoff and causing the deposition of sediment at the structure.

WHERE USED:

Sandbag Sediment Barriers are used at storm drain inlets, across minor swales and ditches, and for other applications where the structure is of a temporary nature.

CONSTRUCTION RECOMMENDATIONS:

a. Should be installed so that flow under or between bags is minimal.

b. Anchoring with steel rods may be required if structure height exceeds two bags.

MAINTENANCE:

Target for vandals; daily inspection required. Clean out trapped sediment after each storm.

FIGURE B-40. Sandbags at site for construction of sediment control structure

FIGURE B-41. Sandbag structure in place

NOTES

SECTIONAL DOWNDRAIN

Technical Information

DEFINITION:

A Sectional Downdrain is a prefabricated, sectional conduit of half-round or third-round, bituminized fiber pipe or other material.

OBJECTIVE:

Sectional Downdrains conduct storm runoff from one elevation to another without erosion of slope.

WHERE USED:

Sectional Downdrains are used as a temporary, interim, or permanent structure on slopes where concentrated runoff would cause excessive slope erosion.

CONSTRUCTION RECOMMENDATIONS:

Formal design required to size pipe.

Placement - On undisturbed soil or compacted fill.

Diameter - Sufficient to carry design flow without spilling from pipe.

Installation Procedure - Supplied by manufacturers in pamphlet form. Skilled labor not required.

Outlet - To stabilized areas only.

MAINTENANCE:

Inspect for damage periodically.

MANUFACTURER:

Sonoco Product Company
Hartsville, South Carolina 29550

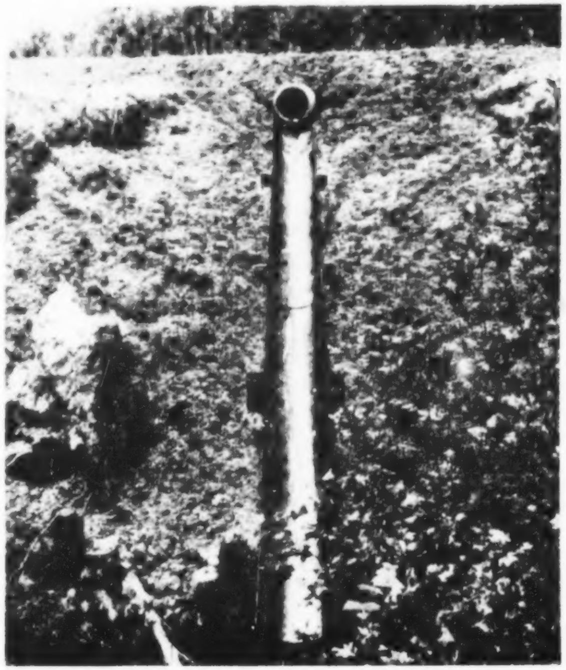


FIGURE B-42. Sectional downdrain

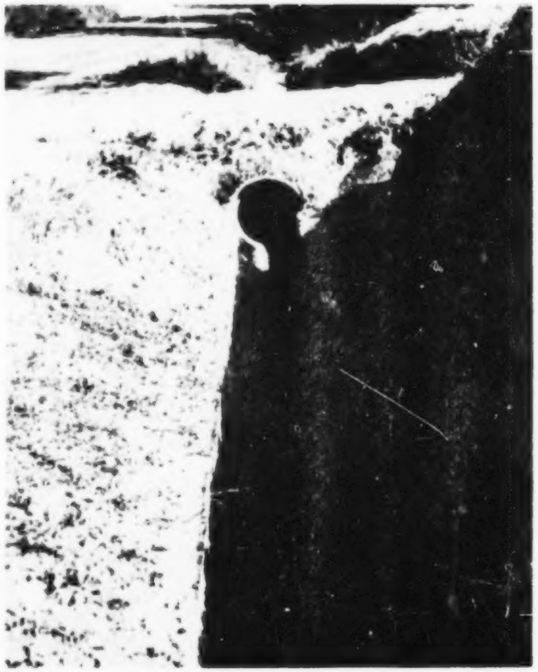


FIGURE B-43. Sectional downdrain used as a ditch liner

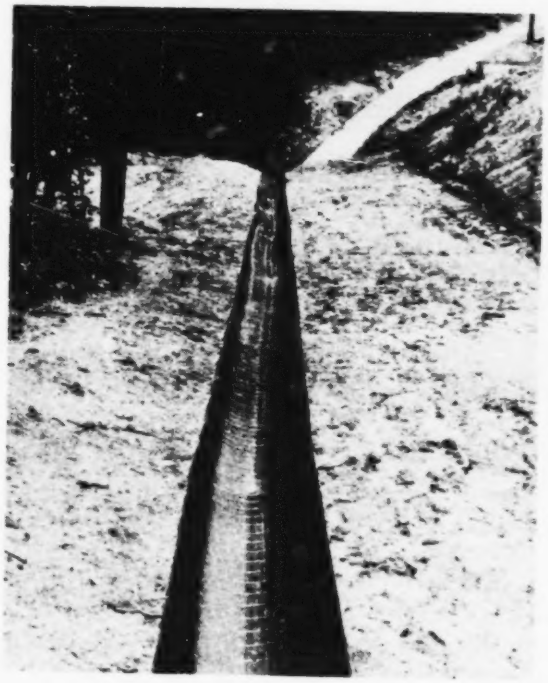


FIGURE B-44. Sectional downdrain

NOTES:

SEDIMENT RETENTION BASINS

Technical Information

DEFINITION:

A Sediment Retention Basin is a temporary dam or basin or a combination of both that will trap and store sediment produced on exposed areas and delivered to the structure by storm runoff.

OBJECTIVE:

Sediment Retention Basins trap and retain sediment generated during construction activities on-site.

WHERE USED:

Sediment Retention Basins are used across channels and drainageways that are on, or adjacent to, construction sites.

DESIGN AND CONSTRUCTION RECOMMENDATIONS:

Formal design is required. The following information has been prepared by the USDA, Soil Conservation Service for specific use within the State of Maryland. The text of the USDA specifications is presented here as an example and is for general interest only. The appendices to the USDA specifications are not included.

U.S. Soil Conservation Service
College Park, Maryland

November 1969

INTERIM STANDARD AND SPECIFICATIONS FOR SEDIMENT BASIN

DEFINITION, PURPOSE, AND CONDITIONS WHERE APPLICABLE:

A sediment basin is created by the construction of a barrier or dam across a drainageway, or by excavating a basin, or by a combination of both, to trap and store sediment from erodible areas in order to protect properties and stream channels below the installation from excessive siltation. This specification applies only to sediment basins that are temporary in nature and will be removed upon completion of the development period.

Sediment basins that are to remain as a water storage facility after the development period will be designed and constructed to conform to Maryland State Law, as found in Article 96A, Maryland Water Resource Law. This practice applies primarily to areas where land grading operations are planned or are underway. It is used as a temporary measure until areas above the installation are permanently protected against erosion by vegetative or mechanical means.

Sediment basins covered by this standard and specification will be limited to the following two categories.

Class "X" - Sediment control basins designed with a dam 10 feet or less in height and with less than one million gallon storage capacity below the pipe spillway crest.

Class "B" - Sediment basins with the following criteria will fall in Class "B": The water surface area at the crest elevation of the pipe spillway shall not exceed nine (9) feet measured upward from the original stream bed to the crest elevation of the pipe spillway; and the drainage area shall not exceed one hundred fifty (150) acres.

NOTE:

This standard and specification shall not apply to sediment basins in which any of the above criteria for Class "B" sediment basins is exceeded.

DESIGN:

Storage - The site should be selected to provide adequate storage for not less than 0.5 inches per acre of drainage area. Volume for trap efficiency calculations shall be the volume below the emergency spillway crest or pipe spillway crest if there is no emergency spillway. When necessary, consideration should be given either to excavating additional storage capacity to meet these requirements or to plan for periodic cleanout in order to maintain the capacity requirements. Where available sites do not lend themselves to meeting such design criteria, approval should be obtained from the Soil Conservation District and the responsible county agency to design and install a sediment basin with less storage.

NOTE:

Sediment basins shall be cleaned out when the effective storage capacity drops below 0.2 inch per acre of drainage area. The elevation corresponding to this level shall be determined and given in the design data as a distance below the top of the riser. 0.5 inch of storage per acre of watershed equals 67 cubic yards per acre of watershed. 0.2 inch of storage per acre of watershed equals 27 cubic yards per acre of watershed.

Spillway Design

1. Runoff Computations - Combined capacity of the pipe and emergency spillways will, where applicable, be designed to handle a ten-year frequency storm. Runoff will be figured by an acceptable method and should be based on soil cover conditions expected to prevail during the anticipated effective life of the structure.

2. Pipe Spillways - Design the pipe spillway to handle not less than five inches runoff from the drainage area for 24 hours (i.e., five inches runoff or 0.21 cfs per acre of drainage area). (See Appendix A-2 for capacity of specific pipe combination.) The pipe spillway will consist of a vertical pipe or box type riser joined to a horizontal pipe (barrel) which will extend through the embankment. The riser will be perforated to provide a gradual drawdown in the reservoir to a planned elevation after each storm event. The hydraulic efficiency of the pipe spillway may be increased by using a riser with a cross sectional area of at least 1.5 times the cross sectional area of the horizontal pipe.

   a. Crest Elevation - When used in combination with emergency spillways, the crest elevation of the riser shall be at least one foot below the elevation of the control section of the emergency spillway. If no emergency spillway is provided, the crest elevation of the riser shall be at least three feet below the crest elevation of the embankment.

   b. Perforated Riser - The upper portion of the riser shall be perforated with 1-1/2 inch diameter holes spaced eight inches vertically and 10-12 inches horizontally all around. The perforated portion shall be the top 1/2 to 2/3 of the riser.

c. Antivortex Device - An antivortex device shall be used on the top of the riser if the discharge values in the appended charts are used. If no antivortex device is used, discharge values given in the charts must be reduced by 50 percent. An approved antivortex device is a thin, vertical plate normal to the centerline of the dam and firmly attached to the top of the riser. The plate dimensions are: length = diameter of the riser plus 12 inches; height = diameter of the horizontal pipe.

d. Base - The riser shall have a base attached with a watertight connection and shall have sufficient weight to prevent flotation of the riser. Two approved bases are: (1) A concrete base 18 inches thick with the riser imbedded six inches in the base. The base should be square with each dimension one foot greater than the riser diameter. (2) A 1/4 inch minimum thickness steel plate welded all around the base of the riser to form a watertight connection. The plate shall be square with each side equal to two times the riser diameter. The plate shall have two feet of stone, gravel, or tamped earth placed on it to prevent flotation.

e. Trash Rack - An approved trash rack shall be securely attached to the top of the riser.

f. Antiseep Collars - Conduits through embankments consisting of materials with low silt-clay fractions shall be provided with antiseep collars where the pipe diameter is 10 inches or greater. Seep length should be increased approximately 10 percent. All Class "B" basins shall have a minimum of one antiseep collar.

3. Emergency Spillway

a. Capacity - The minimum capacity for emergency (earth) spillway will be that required to pass the peak flow from design storm less any reduction creditable to the pipe spillway. Where emergency spillways are used, the channel bottom shall have a minimum width of eight inches. Design of emergency spillways can be determined through the use of Appendix A-3.

b. Maximum Allowable Velocity - The maximum allowable velocity in the exit channel shall be 6.0 feet per second.

c. Vegetative Protection - Provide for the protection of the embankment and emergency spillway by vegetative or other suitable means. See Standard and Specifications for Critical Area Stabilization.

4. Freeboard - Freeboard is the difference in elevation between design high water (10 year storm as outlined above) and the top of the settled embankment. Minimum freeboard shall be 1.0 feet for sediment basins with emergency spillways and 2.0 feet for those with no emergency spillway.

Embankment - The embankment shall have a minimum top width of eight feet. Side slopes shall be no steeper than 2:1 for the Class "X" sediment basins and no steeper than 2-1/2:1 for the Class "B" sediment basins. The maximum fill height shall be 10 feet for Class "X" basins and 15 feet for Class "B" basins.

Storage Area - Consideration should be given to fencing the sediment storage area.

CONSTRUCTION SPECIFICATIONS:

Site Preparation - Areas under the embankment and any structural works shall be cleared, grubbed, and the topsoil stripped to remove all trees, vegetation, roots, or other objectionable material. In order to facilitate cleanout and restoration, it is recommended that the pool area (measured at the top of the pipe spillway) be cleaned of all brush and trees.

Embankment

1. Material - The fill material shall be taken from approved designated borrow area or areas. It should be free of roots, woody vegetation, oversize stones, rocks, or other objectionable materials. The embankment shall be raised to an elevation which provides for anticipated settlement to design elevation (allow 10 percent for settlement).

2. Placement - Areas on which fill is to be placed shall be scarified prior to placement of fill. Fill materials shall be placed in six inch maximum lifts which are to be continuous over the entire length of the fill.

3. Compaction - The movement of the hauling and spreading equipment over the fill should be controlled so that the entire surface of each lift will be traversed by not less than one tread track of the equipment or compaction shall be achieved through use of a roller.

Pipe Spillway Installation - The riser must be rigidly and securely fastened to the barrel and the bottom of the riser must be sealed (watertight). The pipe spillway shall discharge at ground elevation below the dam. All pipe joints must be securely fastened and watertight.

Emergency (earth) Spillway Installation - Emergency spillways must be installed and on undisturbed soil (not on fill) by grading. Entrance and exit channels grade must equal design grades; length of level control section will be 10 feet; channel side slopes will be not steeper than 2:1.

Structural Backfill - Backfill material shall be of the type and quality conforming to that specified for the adjoining fill material. The material shall be placed in maximum six inch lifts and hand compacted to equal or exceed the density of the adjoining fill.

INFORMATION TO BE SUBMITTED FOR APPROVAL:

Sediment Basin designs submitted for review to the Soil Conservation District and construction plans submitted to the responsible county agency will include the following:

a. Specific location of the dam

b. Plan view of dam and the storage basin

c. Cross section of dam and emergency spillway; profile of emergency spillway

d. Runoff calculations for 10-year storms

e. Calculations showing design of pipe and emergency spillway

f. Storage Computation (stated in acre feet)

   1. Total required (acre feet)

   2. Total available (acre feet)

   3. Level of sediment when storage drops below 0.2 inches per acre of drainage area

NOTE:

Items d through f above may be submitted using a design data sheet similar to that shown in Appendix A-4.

SEDIMENT BASIN CONSTRUCTION AND MAINTENANCE CRITERIA:

The following are critical to successful installation and operation of Sediment Basins:

a. Locate the dam to provide maximum volume capacity for silt behind the structure.

b. Prepare the dam site by adequate clearing of vegetation and removal of topsoil before beginning dam construction.

c. Level the bed for the pipe spillway to provide uniform support throughout its entire length under the dam.

d. Securely and rigidly fasten the collar connecting the riser to the barrel (as well as collars connecting sections of the barrel) of the pipe spillway; insure a watertight bottom on the riser; hand tamp fill under shoulders and around the pipe; insure that outlet invert of pipe spillway is not more than one foot above streambed.

e. Place the fill in not more than six-inch lifts compacted by construction equipment. A minimum of two (2) feet of hand compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment. Fill materials should be free from roots, woody vegetation, oversize stones, rocks, or other objectionable material. Frozen material should not be used.

f. Construct emergency spillway as per design on undisturbed soil (not on fill). Design width and entrance and exit channel slopes are critical to the ability of the emergency spillway to successfully protect the dam with a minimum of erosion hazard in the spillway channel.

g. Stabilize embankment and emergency spillway by treatment (lime and fertilizer) sodding or seeding and mulching.

h. When trap efficiency drops below 0.2 inch per acre of drainage area, the sediment basin should be cleaned out to store its original capacity.

MAINTENANCE:

Inspect after each storm. Remove sediment each and every time the structure capacity has been reduced by the factor determined in structure design. Sediment must be disposed of or stabilized in a manner that will preclude its return to downstream areas during storm runoff events.

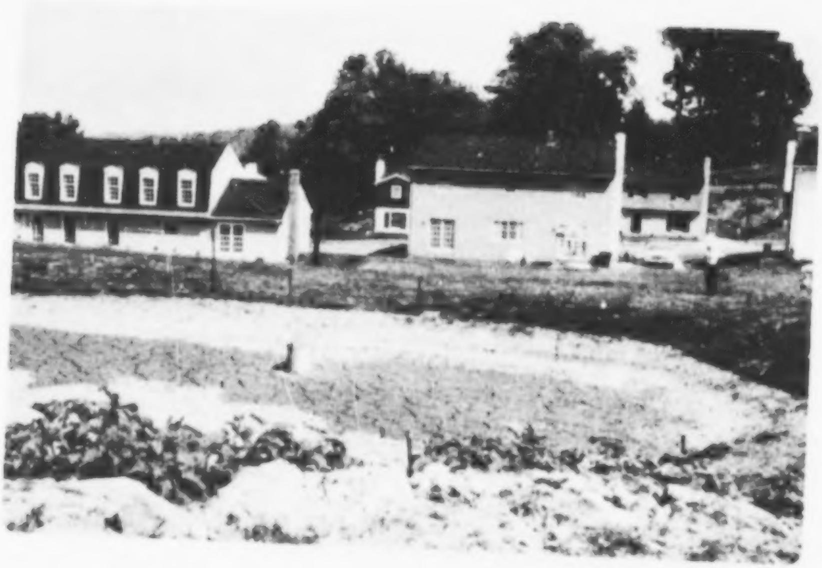


FIGURE B-45. Sediment retention structure - small, less than 1/4 acre

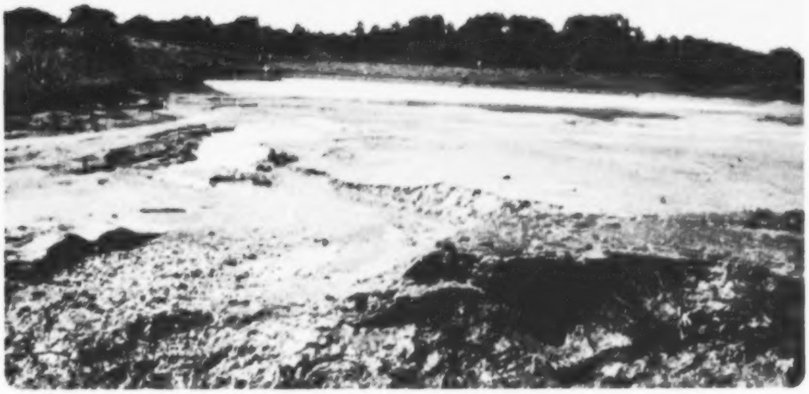


FIGURE B-46. Sediment retention structure - Large, 4 acres. Will be converted for recreational use after development is complete.

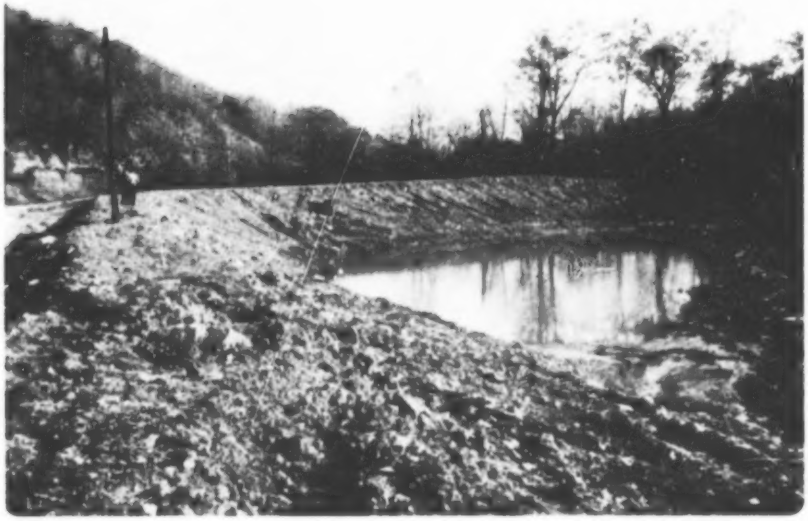


FIGURE B-47. Sediment retention structure - 1 acre

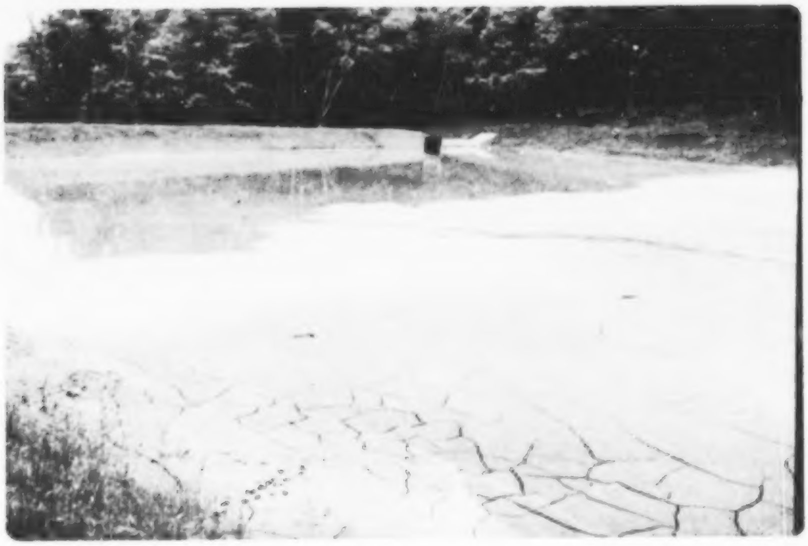


FIGURE B-48. Sediment retention structure - maintenance past due

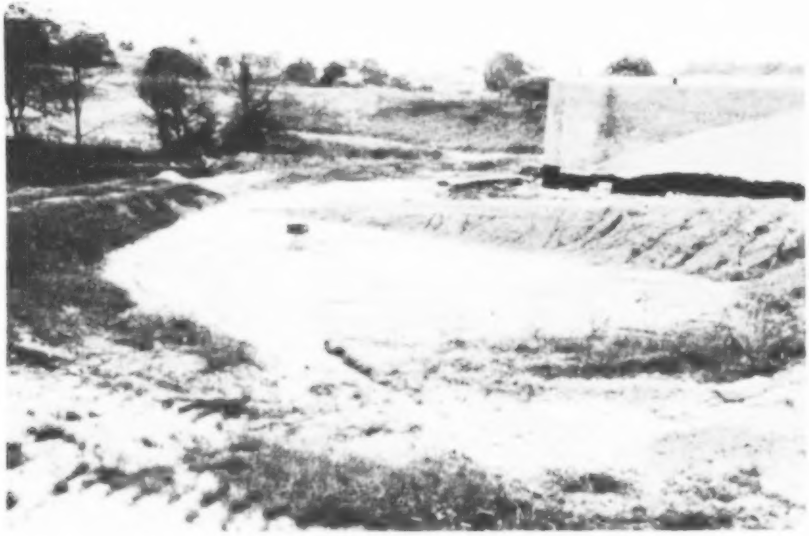


FIGURE B-49. Sediment retention structure now requiring maintenance (cleanout)

NOTES

STRAW BALE SEDIMENT BARRIERS

Technical Information

DEFINITION:

Straw Bale Sediment Barriers are temporary berms, diversions, or other barriers that are constructed of baled straw.

OBJECTIVE:

Straw Bale Sediment Barriers retain sediment on-site by retarding and filtering storm runoff.

WHERE USED:

The barriers are used at storm drain inlets; across minor swales and ditches; as training dikes and berms; along property lines; other applications where the structure is of a temporary nature and structural strength is not required.

CONSTRUCTION RECOMMENDATIONS:

a. Bales bound with nylon or wire are more durable than twine bound bales.

b. Bales should be anchored to the ground with steel pins, fence posts, rebars, wood pickets, etc. Two anchors per bale are required.

c. Bales must be installed so that runoff cannot escape freely under the bales.

MAINTENANCE:

Bales are target for vandals; daily inspection required. They must be replaced when rotten or disintegrating. Remove sediment from bale structures after each storm.

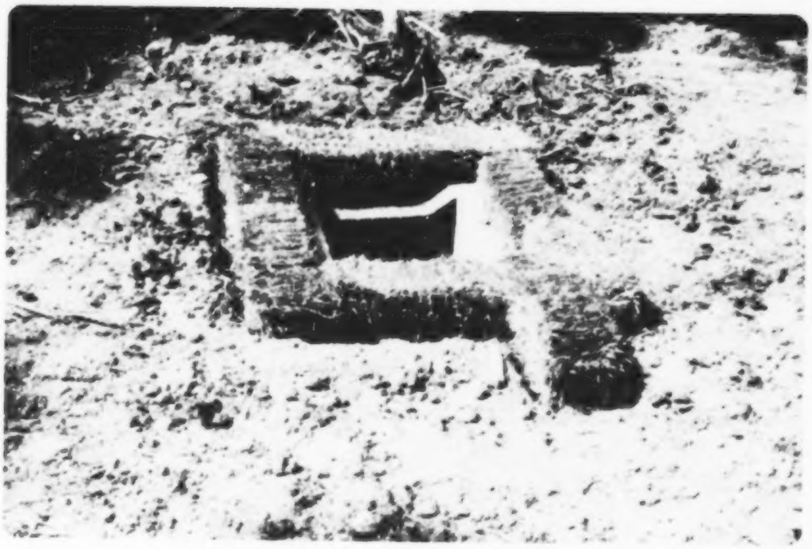


FIGURE B-50. Straw bale structure at storm drain inlet

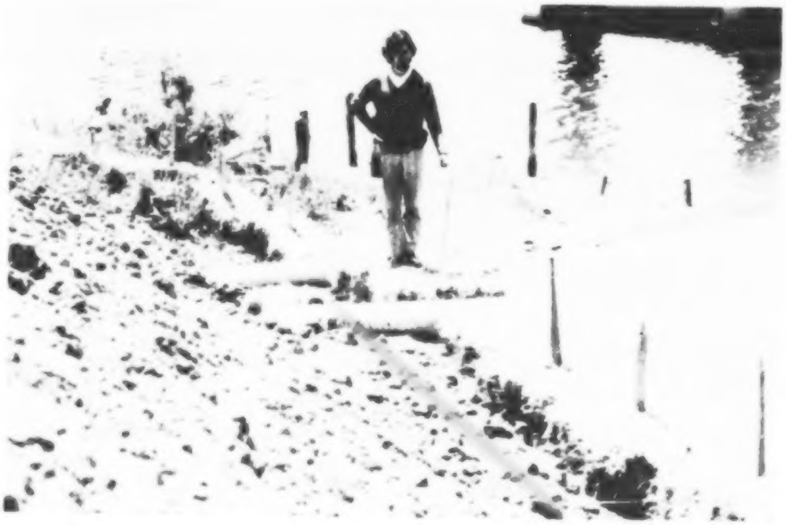


FIGURE B-51. Straw bale structure at toe of sediment retention structure (tidal)

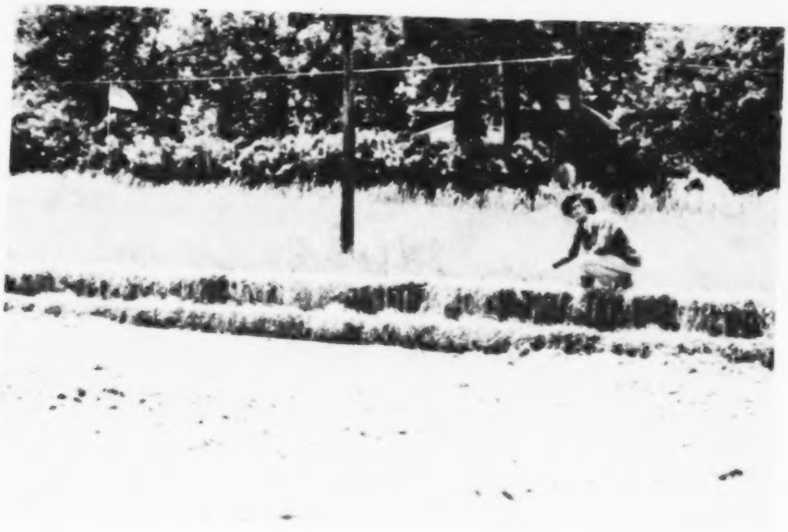


FIGURE B-52. Straw bale structure on property line

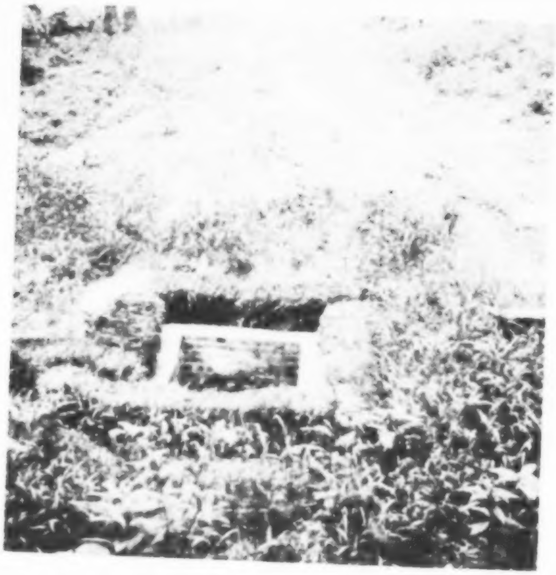


FIGURE B-53. Straw bale structure at storm drain inlet

NOTES

APPENDIX C

FIBER MULCHES, MULCH BLANKETS, AND NETTINGS

EXCELSIOR BLANKET

Technical Information

PRIMARY USAGE:

The Excelsior Blanket is a protective blanket used in the establishment of vegetation in critical areas. As a mulching product it conserves soil moisture, serves as an insulator against intense solar insolation, dissipates energy from falling raindrops, and reduces erosion caused by overland flow. The use of a reinforcing weave, the intertwined nature of the excelsior, and the fact that the blanket is secured to the soil by metal staples make this product resistant to erosion by concentrated storm runoff. It can, therefore, be used in critical areas such as swales, ditches, steep slopes, highly erodible soil, etc.

DESCRIPTION:

The Erosion Control Excelsior Blanket consists of a machine produced mat of curled wood excelsior of 80 percent eight inch or longer fiber length. It is of consistent thickness and the fiber is evenly distributed over the entire area of the Blanket. The top side of each Blanket is covered with a 3" x 1" weave of twisted Kraft paper or biodegradable plastic mesh that has a high wet strength. Blankets are smolder resistant and contain no chemical additives. The Blankets are available in 3' x 150' rolls and in 4' x 180' rolls. They are secured to the soil by the use of heavy duty wire staples.

INSTALLATION INSTRUCTIONS:

Each specific site may require some modification or variation from the general criteria listed below. Manufacturer technical representatives or conservation specialists experienced in the use of this product should be consulted for guidance. In general, the Blanket is rolled out on the seeded area to be protected and is stapled into place. Suggested staple application rate, under normal conditions, is five staples per six linear feet of Blanket, placed two along each side and one in the middle. Where more than one Blanket is required they are butt-joined and securely stapled. Care should be exercised to ensure that the Blanket is placed with the weave side up. When used in areas of concentrated flow they must be extended laterally to an elevation that is several inches above the elevation of the design high flow. This precaution will discourage gully and rill formation along the margins of the installation. An even greater degree of success is often attained if erosion checks (Appendix B) are used in conjunction with the Excelsior Blanket.

PRODUCT INFORMATION SOURCE:

American Excelsior Company
P.O. Box 5067, 850 Avenue H East
Arlington, Texas 76011
(Erosion Control Excelsior Blanket)

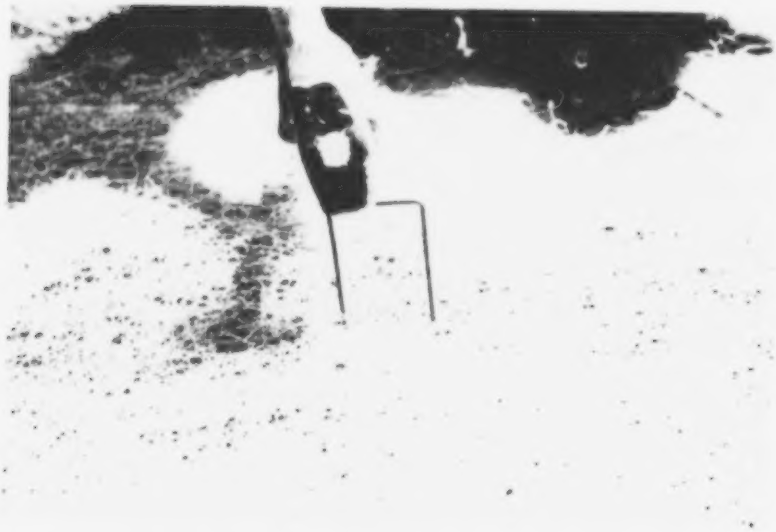


FIGURE C-1. Excelsior blanket and staple

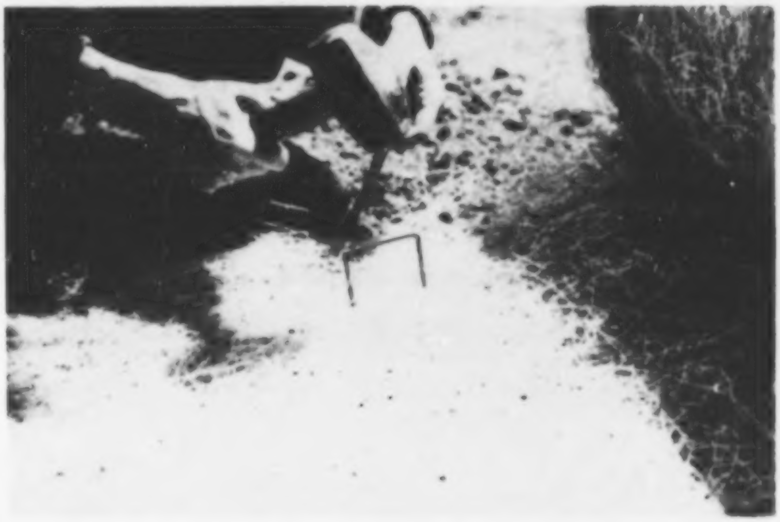


FIGURE C-2. Driving staple to anchor excelsior blanket

NOTES:

FIBER GLASS MATTING

Technical Information

PRIMARY USAGE:

Erosion check (Appendix B) construction is one of the most common applications of Fiber Glass Matting. In its various forms, it is also used in landscaping as a filter-separator between topsoil and gravel drainage beds, and as a mulch for seedbeds and for other applications. In this document it is only considered in its application for use in the construction of erosion checks and as a mulch for seedbeds.

DESCRIPTION:

Fiber Glass Matting is composed of flexible fiber glass that is made of inorganic materials that will not rot, corrode, or burn. It is supplied in rolls of material 1/2-inch thick. Roll width can be variable from two to six feet. Roll length varies from 100 to 150 feet.

INSTALLATION INSTRUCTIONS:

At locations where erosion checks are planned a trench is dug across the ditch, swale, slope, etc. See Erosion Check (Appendix B) for trench details. Place fiber glass matting in an "L" shape with the long dimension up; staple matting against the vertical side of the trench and along the bottom sufficiently to hold it in place. Backfill, tamp, and trim matting flush with the surface.

Where long-term resistance to erosive forces is desired in conjunction with vegetation, Fiber Glass Matting can be used as a mulch blanket. It is applied in a similar manner to the Excelsior Blanket. (See this Appendix for details).

PRODUCT INFORMATION SOURCE:

Certain-Teed Products Corporation
Gustin-Bacon Division
3050 Fairfield Road
P.O. Box 15079
Kansas City, Kansas 66115
(Ultracheck®)

PPG Industries, Inc.
Fiber Glass Division
One Gateway Center
Pittsburgh, Pennsylvania 15222

(Topsoil Separator)

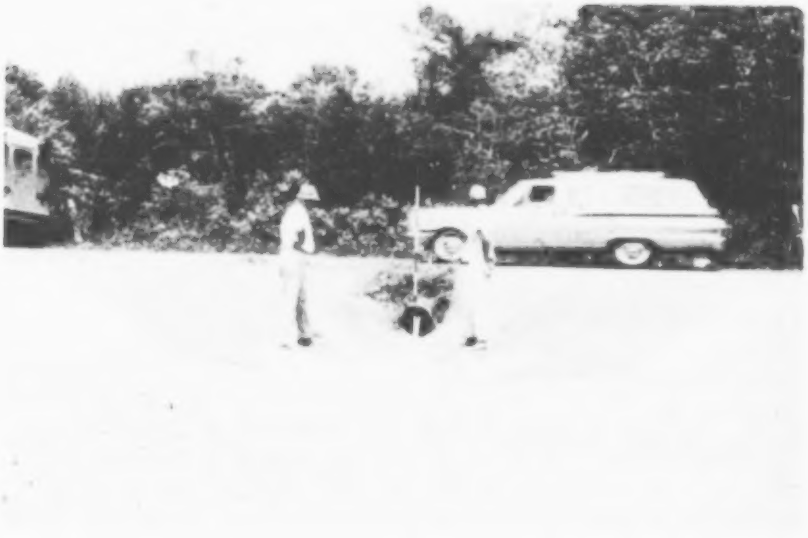


FIGURE C-3. Fiber glass mat at culvert invert

GLASSROOT®

Technical Information

PRIMARY USAGE:

GLASSROOT® is a mulch product for use on newly seeded areas. As a mulching product it conserves soil moisture during dry periods, serves as an insulator against intense solar energy, dissipates energy from falling raindrops, and reduces erosion caused by overland sheet flow.

DESCRIPTION:

GLASSROOT® is a fiber glass product. Its appearance is somewhat similar in appearance to the "angel hair" used in Christmas decorations. It consists of a bundle of continuous fiber glass rovings that are packaged in 35 pound units. It is dispensed by means of a simple application kit that consists of a light metal container complete with shoulder strap for easy carrying, a valve and nozzle, and a 50-foot hose. The hose is connected to an air compressor unit operating at 50 to 60 pounds pressure. As GLASSROOT® is fed into the nozzle, compressed air propels and separates the strands of glass fibers, spreading them evenly over the area. GLASSROOT® is inorganic and will not react or decompose when exposed to water, sunlight, or chemicals found in the soil.

INSTALLATION INSTRUCTIONS:

Conduct normal seeding operations. Apply GLASSROOT® at the rate of about 35 pounds per 150-200 square yards. This rate can be varied depending upon individual site conditions and as experience with the product is acquired. Tacking is generally not required because the fiber glass strands tend to "attach" to every tiny surface irregularity and thereby anchor the mulch. Since this product is nonbiodegradable, it provides reinforcement to turf. Foot traffic by animals and humans on mulched areas should be discouraged until such time as the mulch has become an integral part of the turf.

PRODUCT INFORMATION SOURCES:

PPG Industries, Inc.
Fiber Glass Division
One Gateway Center
Pittsburgh, Pennsylvania 15222

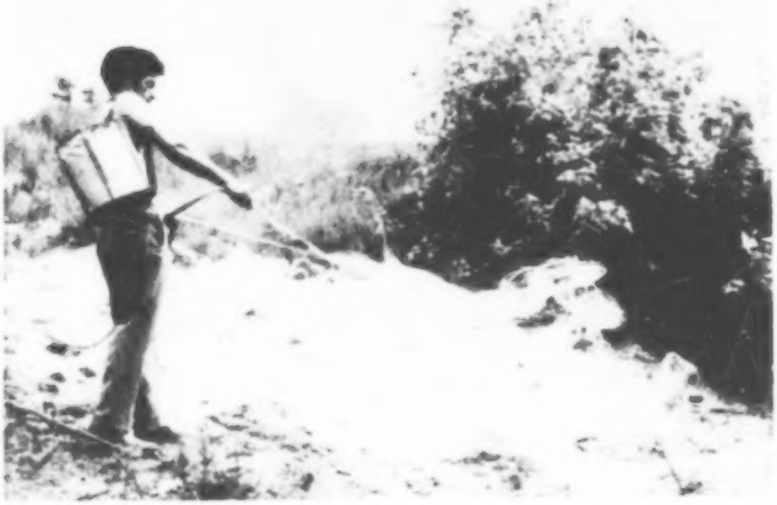


FIGURE C-4. GLASSROOT® application

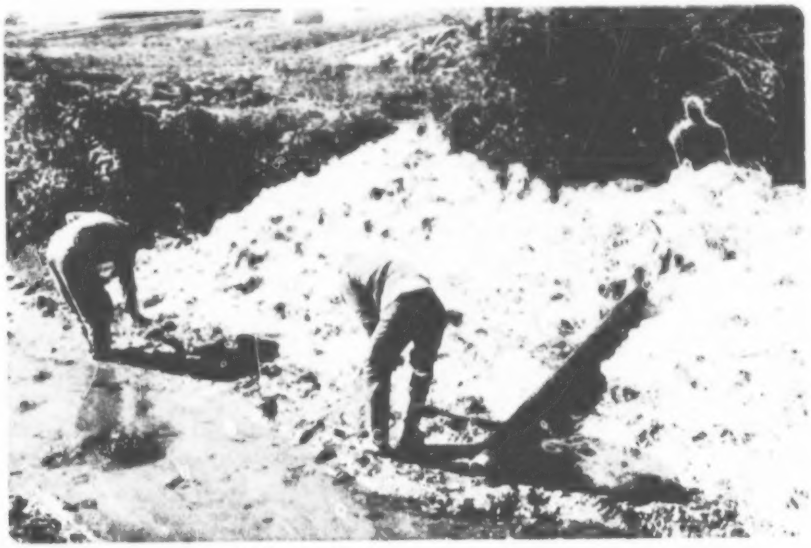


FIGURE C-5. GLASSROOT® in place

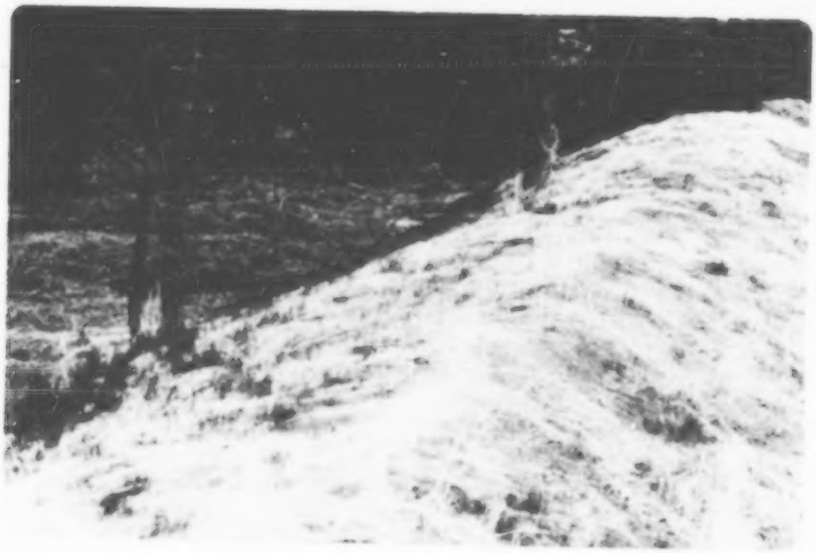


FIGURE C-6. GLASSROOT® in place - vegetation starting

NOTES:

JUTE NETTING

Technical Information

PRIMARY USAGE:

Jute Netting is used in the establishment of vegetation in critical areas. As a mulching product, it conserves soil moisture, serves as an insulator against intense solar insolation, dissipates energy from falling raindrops, and reduces erosion caused by overland flow. The thick strands and heavy weave enable this product to withstand the higher flow velocities associated with critical swales, ditches, median strips, etc.

DESCRIPTION:

Jute Netting is a heavy woven jute mesh of rugged construction. It is constructed of undyed and unbleachedtwisted jute fibers. It can be treated to be smolder resistant. It is commonly available in individual rolls, 225 feet long and 4 feet wide. Each roll contains 100 square yards and weighs approximately 90 pounds.

INSTALLATION INSTRUCTIONS:

Prepare seedbed according to local specifications. Seeding may be split so that one-half of seed is sown after the jute has been applied. Each specific site may require some modification or variation from the general criteria listed below. Manufacturer technical representatives or conservationists experienced in the use of this material should be consulted for specific guidance.

In general, start laying the thatching from the top of the channel and unroll downgrade so that one edge of the strip coincides with the channel center. Lay a second strip parallel to the first on the other side of the channel and allow a two-inch overlap. If one roll of thatching does not extend the length of the channel, continue downhill with additional rolls.

Bury the top end of the jute strip in a trench four inches or more deep. Tamp the trench full of soil. Reinforce with a row of staples driven through the jute about four inches downhill from the trench. These staples should be about 10 inches apart. Then staple the overlap in the channel center. These staples should be 4 to 10 feet apart. The outside edges may be stapled similarly at any time after the center has been stapled. Closer stapling along the sides is required where concentrated water may flow into the channel.

Succeeding strips of thatching, farther down the channel, are secured in a similar manner.

Where one roll of thatching ends and another roll begins, the end of the top strip overlaps the trench where the upper end of the lower strip is buried. Make the overlap at least four inches and staple securely. If the ends and edges of the strips of thatching are securely stapled, stapling in the strip middles may be 10 feet apart or omitted entirely.

At any point the thatching may be folded for burying in slit trenches and secured as were the upper ends. This checks water flow and erosion that may begin under the matting. It also gives improved tie-down.

Insure contact between thatching and soil by rolling after laying, stapling, and seeding is complete. Perfect contact is vital to keep water flow over, not under, the jute.

After job completion, make sure the thatching is in contact with the soil at all places and that critical areas are securely stapled down.

Hairpin-shaped wire staples, No. 8 gauge; 6, 8, and 10 inches long have been used. The longer staples are used in loose or wet soil. Wire staples are better than wooden pegs because the staples can be driven flush with the matting. Wooden pegs extend above the thatching and may catch trash that diverts water flow out of the thatch-protected channel. Wooden pegs may also set up a damaging turbulence.

The use of erosion checks (Appendix B) in conjunction with jute is strongly recommended.

PRODUCT INFORMATION SOURCE:

Belton Bagging Company
P.O. Box 127
Belton, South Carolina 29627

Bemis Company, Inc.
P.O. Box 12224 Soulard Station
2400 South Second Street
St. Louis, Missouri 63104

Ludlow Corporation
Textile Division
Needham Heights, Massachusetts 02194

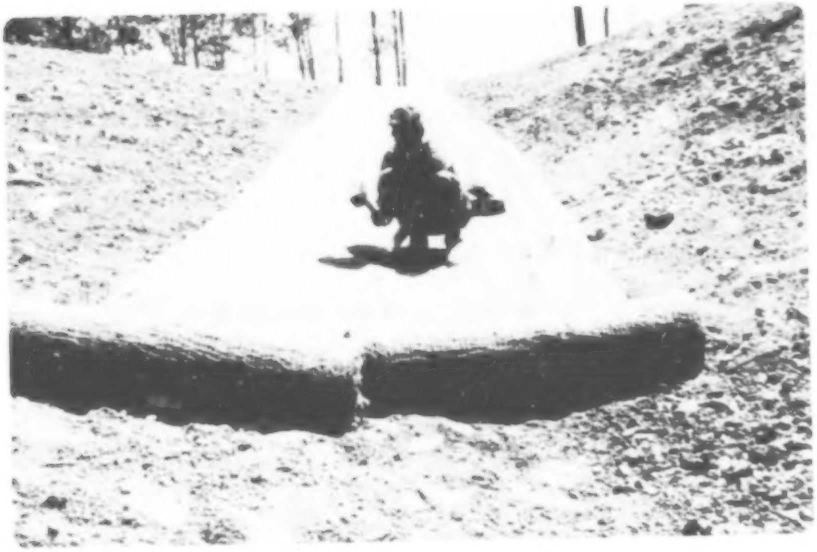


FIGURE C-7. Jute netting being installed

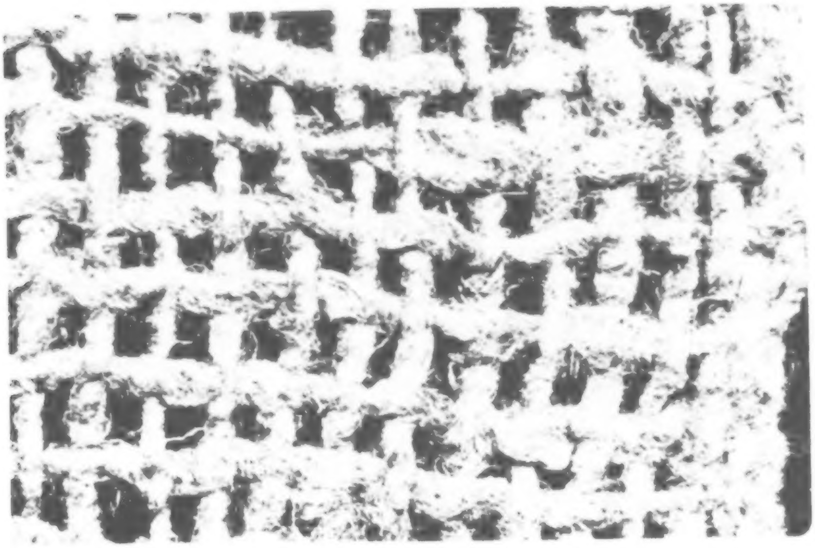


FIGURE C-8. Jute netting - close-up

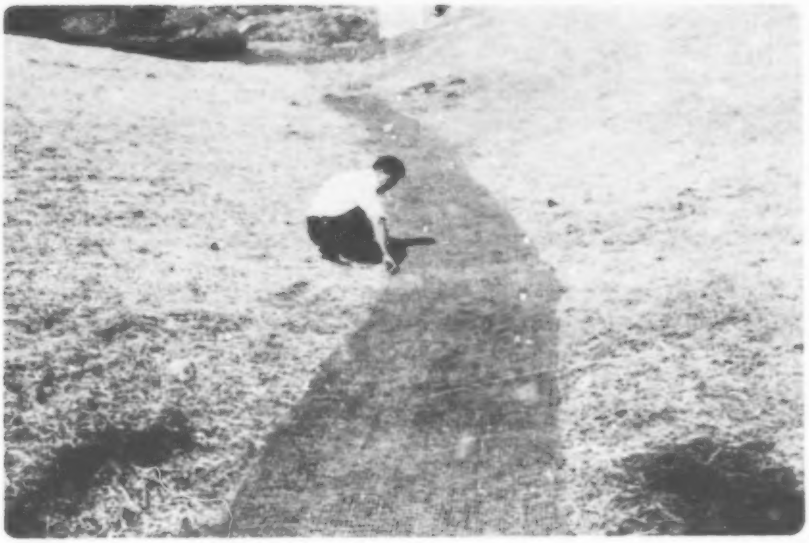


FIGURE C-9. Jute netting over straw mulch in a drainageway

NOTES:

MULCH BLANKETS

Technical Information

PRIMARY USAGE:

Mulch Blankets are used in the establishment of vegetation in critical areas. As a mulching product they conserve soil moisture, serve as insulators against intense solar insolation, dissipate energy from falling rain, and reduce erosion caused by overland flow.

DESCRIPTION:

Conwed Turf Establishment Blanket is a composite of all new cellulose fibers that are bonded with a water soluble binder that is noninjurious to seed germination or growth. The bound material forms a homogeneous mat. An extruded, oriented plastic net with approximate 1/4-inch by 1/4-inch mesh openings is bonded to the top surface of the mat. The blanket is supplied in rolls wide and 200 feet long. The material weighs approximately 25 pounds per 1000 square feet. After application and saturation by rain, the fibrous blanket loosens to form a thick mulch cover. This cover and the underlying seed and soil is then held in place by the mesh plastic net. The fiber mulch blanket conforms to the surface to prevent erosion by wind and water.

Swif-Gro is a lightweight, all cotton woven (leno weave), open mesh fabric laminated to cellulose tissue. Tensile minimum is 45 pounds in the wrap direction and 35 pounds in the filling direction. Roll length is approximately 500 yards. Roll width is 75 inches, plus two inches, minus one inch. One roll weighs 170 pounds ± 10 percent.

INSTALLATION INSTRUCTIONS:

Specific sites may require some modification or variation from the general criteria listed below. Manufacturer technical representatives or conservation specialists experienced in the use of this product should be consulted for guidance. Both materials are designed to be unrolled and stapled over prepared, seeded soil surfaces. Where more than one roll of material is required, sufficient overlap should be provided to ensure against separation at these seams. Neither material should be stretched tight. They should be applied so as to conform to surface irregularities and must be in continuous contact with the soil surface. Material should be secured in depressions with additional staples. Care must be exercised to ensure that the Conwed Turf Establishment Blanket is installed with the plastic net on top. When used in areas that experience concentrated overland flow, fabric blankets must be extended laterally to an elevation that is several inches above the elevation of the design high flow. The use of erosion checks (Appendix B) in conjunction with these products is strongly recommended.

PRODUCT INFORMATION SOURCE:

Conwed Corporation
332 Minnesota Street
St. Paul, Minnesota 55101
(Conwed Turf Establishment Blanket)

Southern Phenix Textiles, Inc.
Box 1108
Phenix City, Alabama 36867
(Swif-Gro)

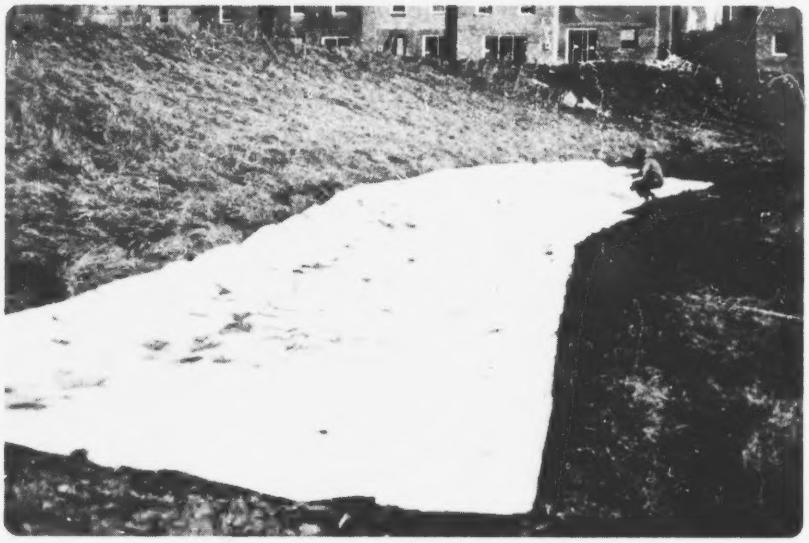


FIGURE C-10. Mulch blanket being installed

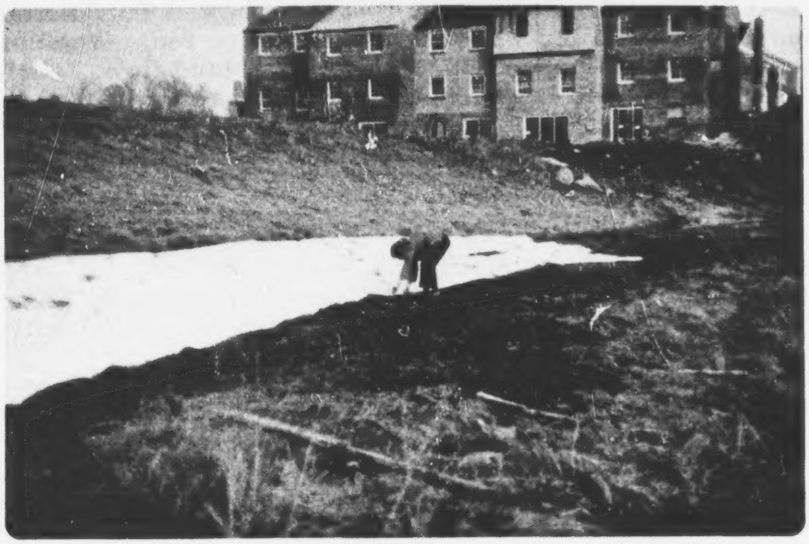


FIGURE C-11. Mulch blanket being stapled

NOTES:

NETTING

Technical Information

PRIMARY USAGE:

Netting is used as a means by which natural or synthetic fiber mulch can be securely anchored on seeded areas or areas temporarily stabilized with mulch on which conventional mulch tacking products (asphalt, chemicals, etc.) are judged to be insufficient. This approach to tacking mulch is often used on very steep areas and on odd shaped areas, especially around structures. Nettings are also used to reinforce newly placed turf that may be subjected to severe runoff velocities before the root zone has matured to the point where turf structure alone can withstand the anticipated stress.

DESCRIPTION:

Several products are on the market and compostions range from tightly twisted Kraft paper yarns to polypropylene oriented plastic to fiber glass scrim. All are lightweight. The Kraft paper yarns are biodegradable. The polypropylene is ultraviolet sensitive and gradually disintegrates in the presence of sunlight. The polypropylene net and fiber glass scrim will not support combustion. All products are marketed in rolls. Roll widths range from 3.75 to 15 feet. Lengths range to 2500 feet.

INSTALLATION INSTRUCTIONS:

Generally these products are unrolled and stapled on areas that have been mulched with natural and synthetic fiber mulch. Staple placement is not as critical in securing netting on mulch as it is with some of the other products discussed in this Appendix. Guidance can be secured from manufacturer's technical representatives or conservation specialists familiar with the use of these products.

When used to anchor newly placed sod, stapling becomes more critical and staple placement on 36-inch centers is often used. Netting with small openings is susceptible to heaving as the turf matures.

PRODUCT INFORMATION SOURCE:

Bemis Company, Inc.
P.O. Box 12224 Soulard Station
St. Louis, Missouri 63157
(Mulch net - Kraft paper)

Conwed Corporation
332 Minnesota Street
St. Paul, Minnesota 55101
(Conwed Erosion Control Netting)

PPG Industries, Inc.
Fiber Glass Division
One Gateway Center
Pittsburgh, Pennsylvania 15222
(Fiber glass scrim)

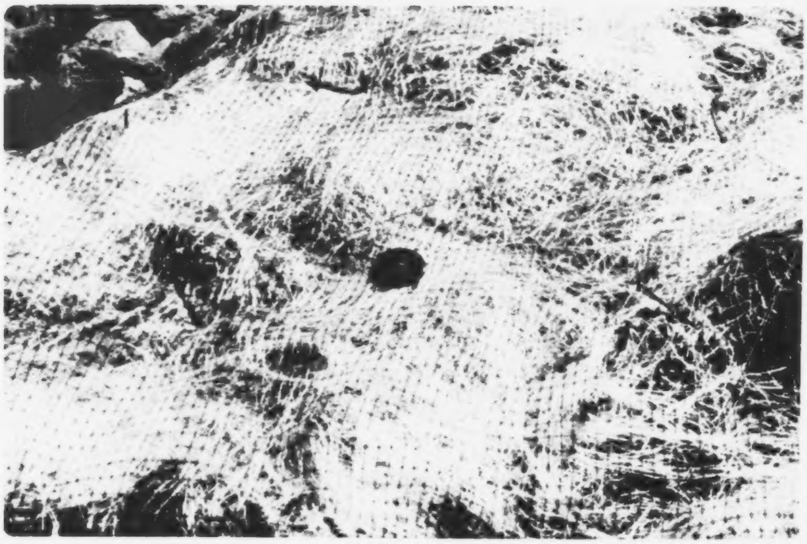


FIGURE C-12. Plastic net over fiber glass roving - close-up

FIGURE C-13. Plastic net (on roll) ready for installation in critical area

NOTES:

PLASTIC FILTER SHEET

Technical Information

PRIMARY USAGE:

Plastic Filter Sheets are used as a replacement for graded filter systems and filter blankets in conjunction with many hydraulic structures.

DESCRIPTION:

Plastic Filter Sheet is a cloth woven of polypropylene monofilament yarns. The cloth is 18 mils thick, weighs 7.35 ounces per square yard, and is not affected by salt water. Porosity is 146 cfm and the cloth is strong and abrasion resistant. It loses no strength when wet and stretches 25 percent before breaking. It is available on rolls of 50 to 200 foot lengths and 6 to 84 foot widths, it can be fabricated with grommeted edges. The material is secured to the soil surface with metal securing pins and staples and with fiber glass rods.

INSTALLATION INSTRUCTIONS:

Each specific site may require some modification or variation of the general criteria listed below. Manufacturer technical representatives or specialists experienced in the use of this product should be consulted for guidance. In general, the material is rolled out onto the prepared surface and secured with specially designed pins, staples, or rods. Where more than one sheet is required, they should be lap jointed to ensure continuous coverage of the area to be protected. When in place, the succeeding layer of materials ie, gravel, rock, can be placed on the filter sheet. Heavy and/or sharp material should be placed with care in order that the integrity of the sheet can be maintained.

PRODUCT INFORMATION SOURCE:

Carthage Mills Incorporated
Erosion Control Division
124 West 66th Street
Cleveland, Ohio 44102

STRAW OR HAY

Technical Information

PRIMARY USAGE:

Straw or hay is a mulch product for use on newly seeded areas. In this capacity, it conserves soil moisture during dry periods, dissipates energy from falling raindrops, serves as an insulator against intense solar energy, and reduces erosion caused by overland sheet flow. It is also used as a temporary measure to protect bare soil areas that have not been seeded. The latter practice is applicable only for relatively short periods of time or until the next seeding season has been reached.

DESCRIPTION:

Generally, unweathered, unchopped small grain straw is used. Wheat straw is preferred. Hay can also be used.

INSTALLATION INSTRUCTIONS:

Straw or hay mulch can be applied by hand spreading (shaking) on small plots and by mulch blowing equipment on larger areas. It is applied at rates of one to two tons per acre. Straw and hay mulch should be tacked to insure against excessive losses by wind and water. Liquid and emulsified asphalt is the most commonly used mulch tack. However, other chemicals (Appendix A) and mulch netting products (Appendix C) are available for use as mulch tacks. Mulch anchoring tools can also be utilized to anchor straw and hay. This equipment consists of a series of notched discs which punch and anchor the mulch material into the soil. Soil must be moist, free of stones, and loose enough to permit disc penetration to a depth of two to three inches if this mulch anchoring technique is to perform in a satisfactory manner.

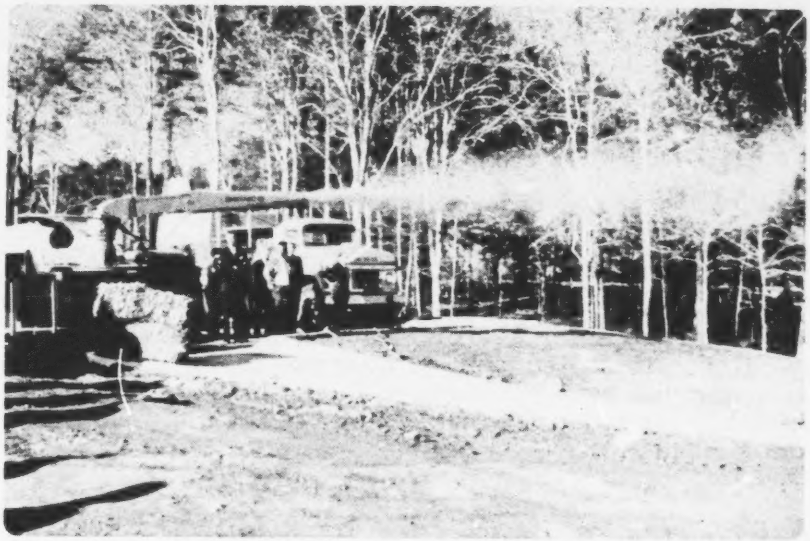


FIGURE C-14. Straw mulch being applied by mulch blower

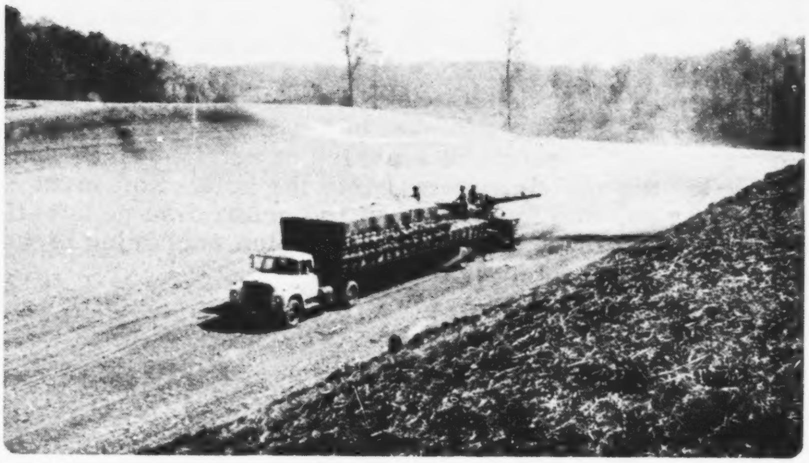


FIGURE C-15. Large straw mulching operation

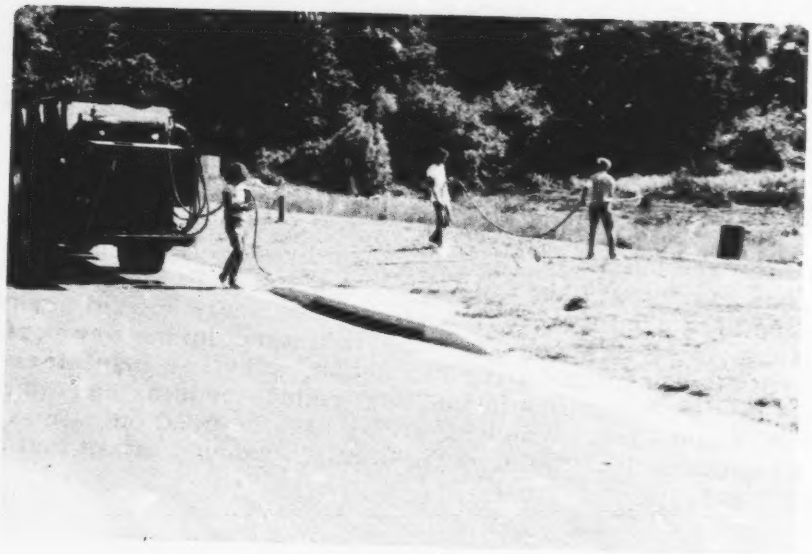


FIGURE C-16. Asphalt being used to tack straw mulch

NOTES:

WOODCHIPS

Technical Information

PRIMARY USAGE:

Woodchips are used as a temporary or interim erosion control technique to protect bare soil areas that have not been seeded. They are also used as a mulch product on newly seeded areas. In this capacity, they conserve soil moisture during dry periods, dissipate energy from falling raindrops, serve as insulators against intense solar insolation, and reduce erosion caused by overland sheet flow. Woodchips may also be used on pathways and to reinforce leaf mold, duff, etc., in wooded areas that are to be preserved.

DESCRIPTION:

Chips of wood are produced by processing tree trunks, limbs, branches, etc., in woodchipping machines. The chips are placed by blower back on the site from which they originate or are placed in trucks for transport to other sites where they are spread for use.

INSTALLATION INSTRUCTIONS:

As a temporary technique on unseeded areas, the chips are placed by machine or spread by hand tools. Application rates range from 4 to 6 cubic feet of woodchips per 100 square feet of area. This application rate is ample to protect bare soil under normal conditions. If intensive foot or vehicle traffic is anticipated, this rate may be increased to the point where woodchip depths of several inches are attained. This very heavy application rate is particularly applicable to yard areas adjacent to homes under construction if autos and light trucks drive and park in the yard area.

As a mulching product on newly seeded areas, woodchips may be placed by machine blower or by hand from stockpiles. Application rates of 60-100 cubic yards per acre are commonly recommended. Mulching with woodchips has proven successful when used with late fall seeding operations that require protection over winter. Experimental work is needed to perfect seed mixtures for this type of operation. However, the wood chip mulch has proven to be satisfactory under these conditions.

As more interest in preserving "natural" woodland conditions on construction sites is expressed, the use of woodchips to supplement existing leaf mold, duff, etc., is accelerating. Chips that cannot be utilized in mulching operations can safely be returned to the forest floor to supplement existing organic cover. This technique is beneficial in that it upgrades the woodland surface area and provides a means to recycle rather than dispose of a natural by-product.

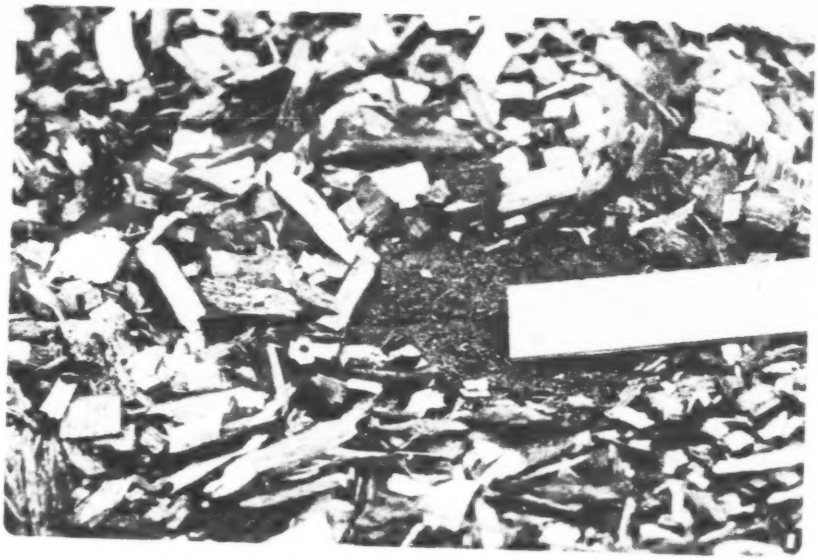


FIGURE C-17. Woodchips - application rate is 4 cubic feet per 100 square feet of area

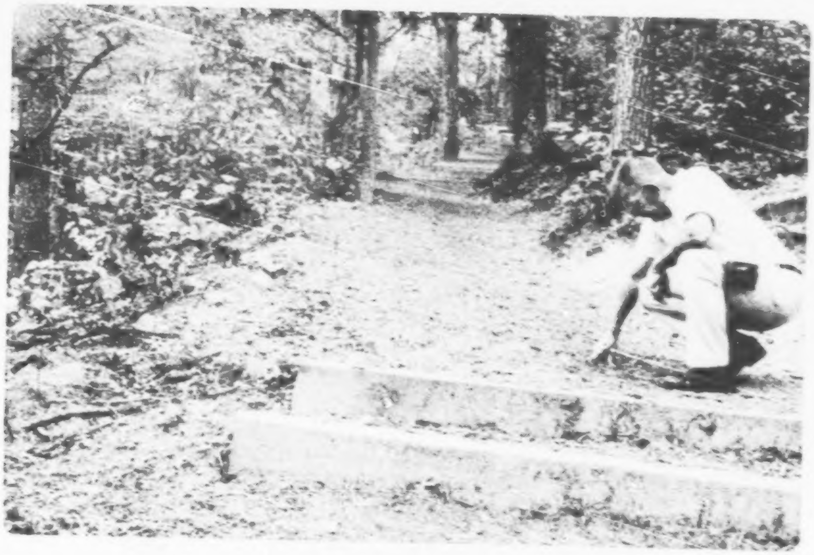


FIGURE C-18. Walkway of woodchips

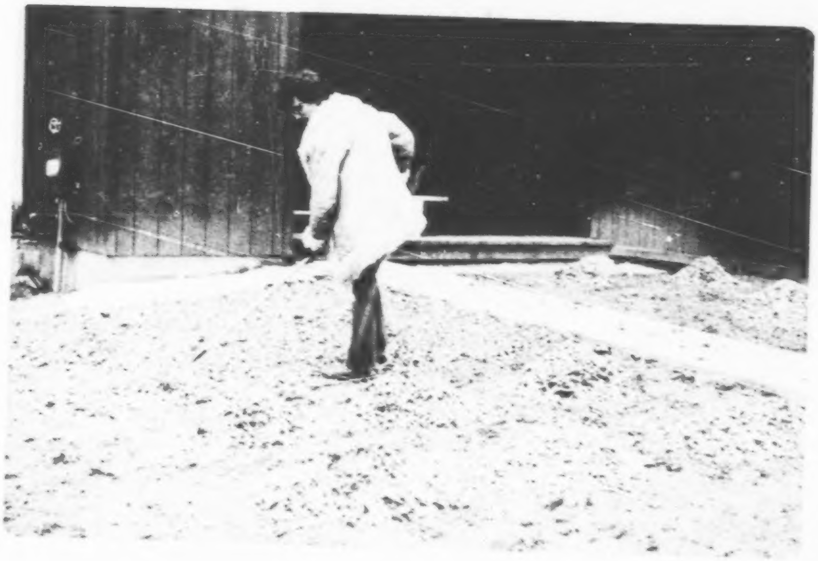


FIGURE C-19. Spreading woodchips on homesite

NOTES

WOOD FIBER MULCH

Technical Information

PRIMARY USAGE:

Wood fiber mulch is specifically designed for use as a hydraulically applied mulch that aids in the establishment of turf or other seeded or sprigged ground covers. As a mulching product, it conserves soil moisture, serves as an insulator against intense solar insolation, and dissipates energy from falling raindrops.

DESCRIPTION:

Wood fiber mulch is a natural, short fiber product, produced from clean, whole wood chips. A nontoxic dye is used to color the mulch green in an effort to aid visual metering in its application. It is evenly dispersed and suspended when agitated in water, and when applied uniformly on the surface of the soil, the fibers form an absorbent cover, allowing percolation of water to the underlying soil. Wood fiber mulch has the following physical properties:

Property	Nominal Value
Moisture Content	9.0-12.0% ± 3.0%
Organic Matter (Oven-Dried Basis)	99.2-99.6% ± 0.2%
Ash Content	0.4-0.8% ± 0.2%
Water Holding Capacity (grams of water/100 grams of fiber)	at least 1080-1150 grams

Wood fiber mulch contains no growth or germination inhibiting factors. In hydroseeder slurries, it is compatible with seed, lime, fertilizer, etc. It is packaged in Kraft paper bags containing 50 pounds each.

INSTALLATION INSTRUCTIONS:

Wood fiber should be applied by hydroseeder at rates of 1000-1500 pounds per acre. It is introduced into the slurry tank after the proportionate quantities of seed, fertilizer, etc., have been introduced. The components are agitated into a well mixed slurry and are sprayed onto the sites or plots to be seeded.

PRODUCT INFORMATION SOURCES:

CONWED® HYDRO MULCH
Conwed Corporation
332 Minnesota Street
St. Paul, Minnesota 55101

WEYERHAEUSER SILVA-FIBER®
Weyerhaeuser Company
Fiber Products Department
Tacoma, Washington 98401

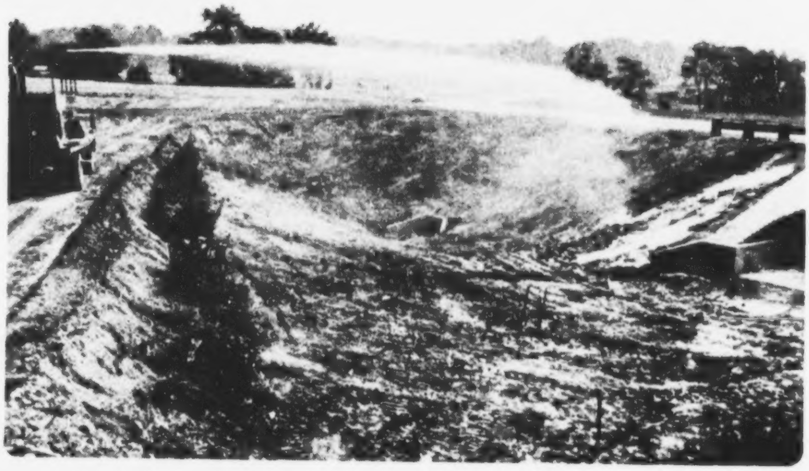


FIGURE C-20. Wood fiber (short fiber) being applied in hydroseeder slurry

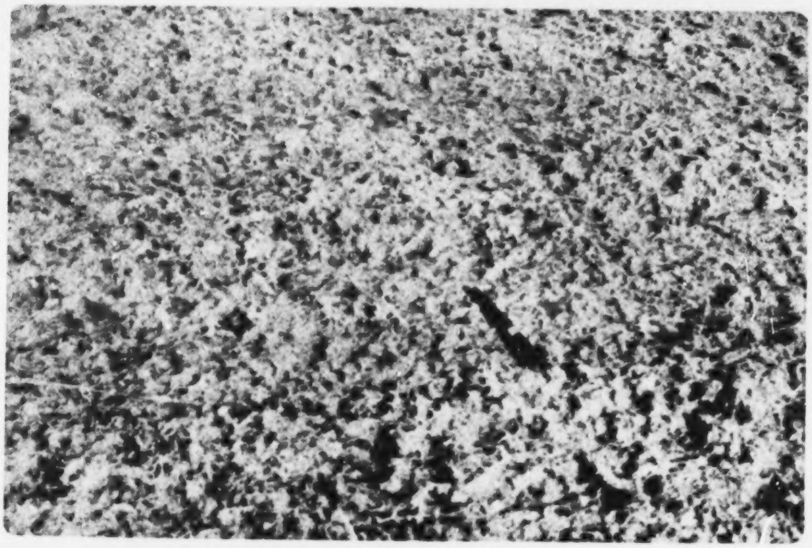


FIGURE C-21. Wood fiber mulch in place (close-up)

NOTES:

APPENDIX D

SPECIAL EROSION AND SEDIMENT CONTROL PRACTICES

CONSTRUCTION COORDINATION

Technical Information

One of the primary rules for a good sediment and erosion control plan is that the minimum area should be exposed for the minimum amount of time. The chances for realization of these minimums can be improved by good construction coordination techniques.

Construction coordination has been a fact for many years. We are now faced with the reality of incorporating another parameter into the construction coordination effort. The new factor is sediment and erosion control. Many builders and developers no longer "rough grade" far in advance of subsequent construction activities. Rough grading in late fall or winter, without the implementation of an acceptable plan to reduce erosion and sediment, is being discouraged.

The advent of total underground utility construction requires that this phase of construction activity be included in any attempt to reduce sediment and erosion by the closer coordination of construction activities. Consider, for example, the development where storm sewer, water, sanitary sewer, electricity, telephone, and gas utilities are all constructed subsurface. Construction practice incorporates very little coordination of the installation of these services. There is a great need to shorten the time period from the start to the finish of underground construction. Argument can be made that simultaneous installation is not possible. If this argument is accepted, the questions of how much time lapse is acceptable between the completion of one and the start of the next and, can this period be shortened by the closer coordination of underground construction effort must be asked.

Another question that is being raised is why each service must be in a separate trench. One school of thought suggests that the "utilidor" concept, where more than one service is combined in a common trench, be adopted in an effort to disturb smaller areas or to disturb a given area for a shorter period of time. The opposition group suggests that this approach is not acceptable in development construction.

Unfortunately, no simple answer exists to these questions. However, answers will be forthcoming if these questions are seriously considered and if they are incorporated into the coordination of future construction activities.

NOTES

MULCH ANCHORING

Technical Information

DEFINITION:

Mulch Anchoring is the anchoring of long fiber mulch by the use of mechanical equipment rather than by chemical tacking or the use of confining nettings.

DESCRIPTION:

A mulch anchoring tool is often used to secure straw and hay mulch. It is composed of a series of notched discs which anchor the mulch by punching it into the soil. The same effect can be achieved on a limited basis by the use of a tracked vehicle equipped with grouser bars (treads) that are at least 1-1/4 inches long.

NOTES:

In order for mulch anchoring to be effective, the soil must be moist, free of stones, and loose enough to permit disc penetration to a depth of 2-3 inches. On slopes the mulch anchoring tool should be used on the contour to secure maximum erosion control.

Since the mulch anchoring tool is limited to use on those slopes upon which a tractor can be safely operated on the contour, the use of a crawler tractor with long treads should be considered on steeper slopes. Soil conditions must be the same for either approach. The crawler should work up and down the slope in order that the tread tracks will be across the slope.

On critical slopes, the combination of mulch anchoring and mulch tacking is recommended so that the seeding operation will have the best possible chance of succeeding.

NOTES

PUMPED WATER MANAGEMENT

Technical Information

DEFINITION:

Pumped Water Management is the control of water being pumped on construction projects so that it will not be deleterious to the environment by eroding soil and providing sediment to downstream areas.

DESCRIPTION:

The only effort required to accomplish proper management of water being pumped on construction sites is to ensure that it is discharged on a stabilized area. This may require the use of extra hose or pipe to reach a stable outlet.

NOTES:

Water being pumped from excavations on construction sites is seldom considered as a source of sediment pollution. However, if the discharge is to a fill slope, highly erodible soil, etc., it unfortunately qualifies. Consideration must now be given to this potential source of erosion and sediment production.

An obvious answer is to pump to a storm sewer. Since storm sewer construction is usually completed before other work begins, this option is generally open. Another possibility is to carry the water by hose to an adjacent water course.

In any event, pumped water discharge onto fill slopes, spoil piles, highly erosive soils, etc., should not be tolerated.

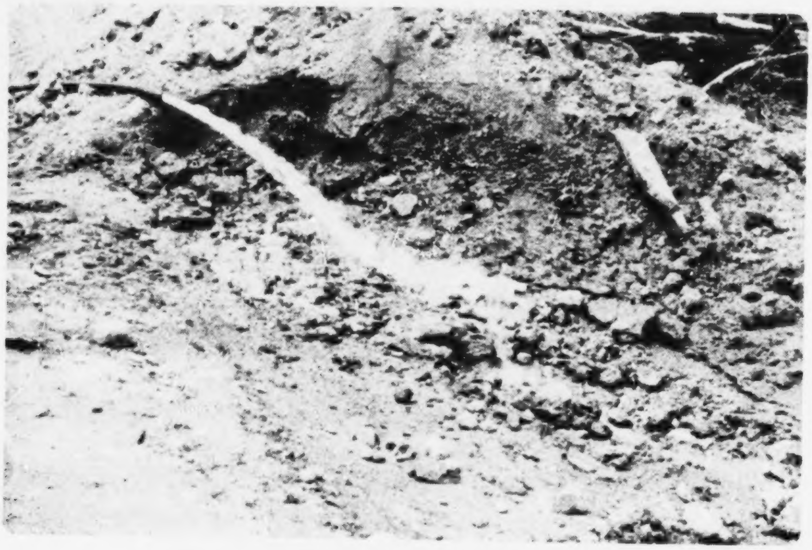


FIGURE D-1. Water being pumped from an excavation and being discharged onto a spoil pile

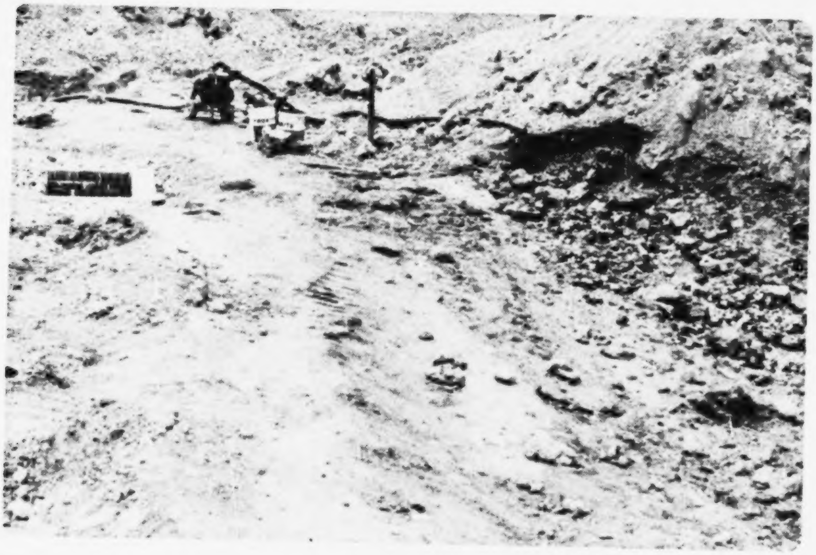


FIGURE D-2. Same area as Figure D-1. Pumped water should be discharged to completed storm drain.

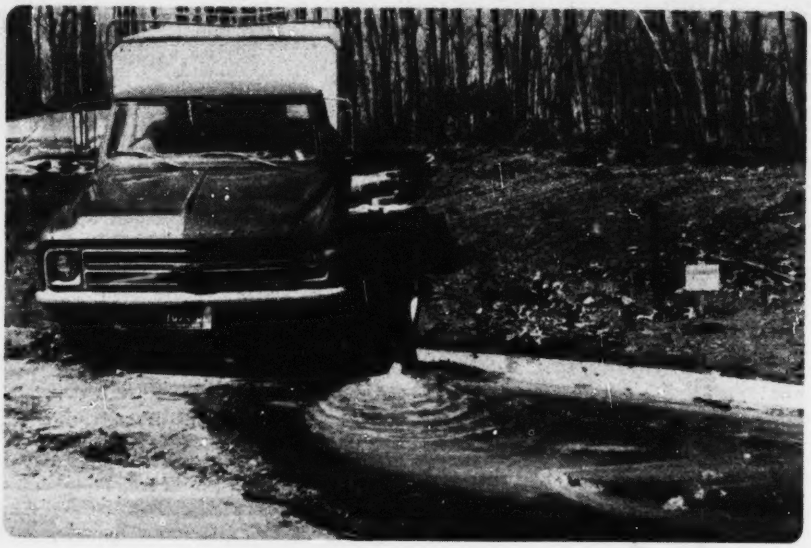


FIGURE D-3. Pumped water being discharged to stable area (surfaced street) rather than to bare soil

NOTES:

ROUGHNESS AND SCARIFICATION

Technical Information

DEFINITION:

In the context of this document, roughness means the uneven or bumpy condition of the soil surface. Scarification is the process of loosening or stirring the soil to shallow depths without turning it over.

DESCRIPTION:

Roughness associated with earth moving activities is typified by surfaces that have not been smooth graded. Scarification is commonly thought of as a means by which rock and/or soil is loosened by bulldozers equipped with ripper attachments. For the purposes of this discussion, scarification is accomplished by smooth grading an area by means of a bucket (front end loader) equipped with "teeth." It can also be created by the grouser bars on crawler tractors.

NOTES:

For the purposes of sediment and erosion control, roughness and scarification can be utilized to reduce the production of sediment and to aid in the establishment of other erosion control practices. As an example, consider a building site that has been temporarily smooth graded with a front end loader equipped with a toothed bucket. If the grading is up and down slope, runoff and erosion are encouraged by the scarification marks. If, however, the grading is accomplished on the contour or across the grade, the scarification marks will tend to retain or retard moisture.

If the surface prepared in the above manner is to be seeded or sodded, the scarification marks take on even greater importance. On a seedbed, the marks trap and retain seed and moisture. This seed is often covered by soil being carried downslope by runoff and may be the only areas in which seed remains after a rather severe storm. If the seed thus trapped is a turf forming grass, it may be sufficient to establish an acceptable vegetative cover without requiring a reseeding program.

Sod laid on steep slopes cut in fine grained soil will often fail to bond with the soil surface and slip to the bottom of the slope if the surface is smooth graded. Scarification marks across the slope will aid in keeping sod in place until its root system has formed an adequate bond with the soil. Nutrients placed under the sod will also be retained in the roughened area better than if the soil surface is absolutely smooth.

Another example is the slope that is to receive a mulch (woodchips) to protect it from excessive erosion between seeding seasons. If the slope has been scarified, the woodchips will adhere to the soil surface with greater tenacity than they will to a smooth graded surface.

Topsoil is often spread on slopes by tracked dozers. If the slope is finished up and down slope, or if a diversion dike (Appendix B) is constructed, the tracks created by the grouser bars on the tractor will improve the roughness of the slope and subsequent seeding or mulching operations will be aided by this roughness.

Infiltration of rainfall is enhanced when a surface is left in a rough condition. This factor is also important when erosion, sediment, and storm runoff controls are planned and implemented together in a total conservation program.

Many other examples are worthy of inclusion in this appendix, but these have been chosen in an effort to point out the advantages of a rough or scarified surface over one that has been smooth graded.

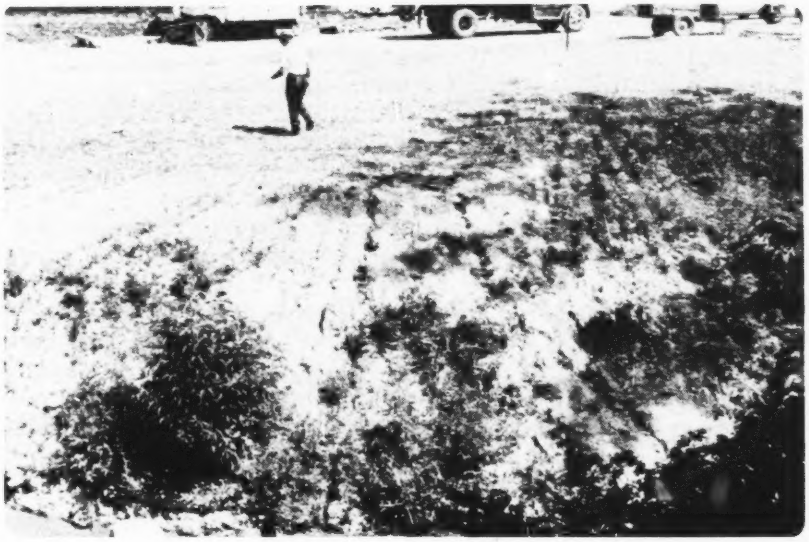


FIGURE D-4. Scarification up and down slope aids erosion

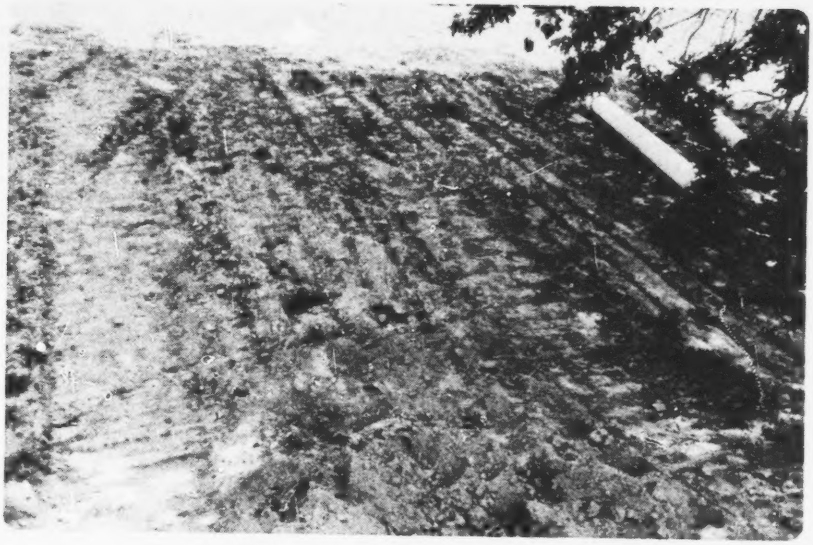


FIGURE D-5. Scarification across slope aids erosion control

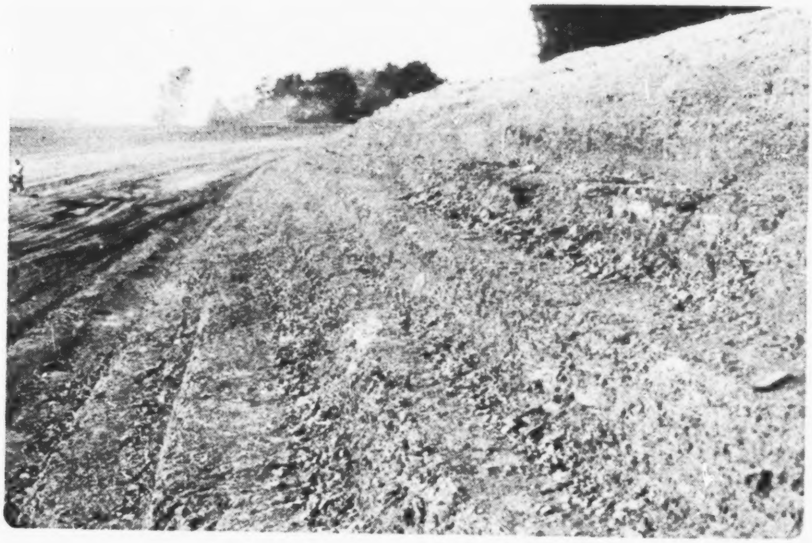


FIGURE D-6. Serrated cut - a type of roughened slope

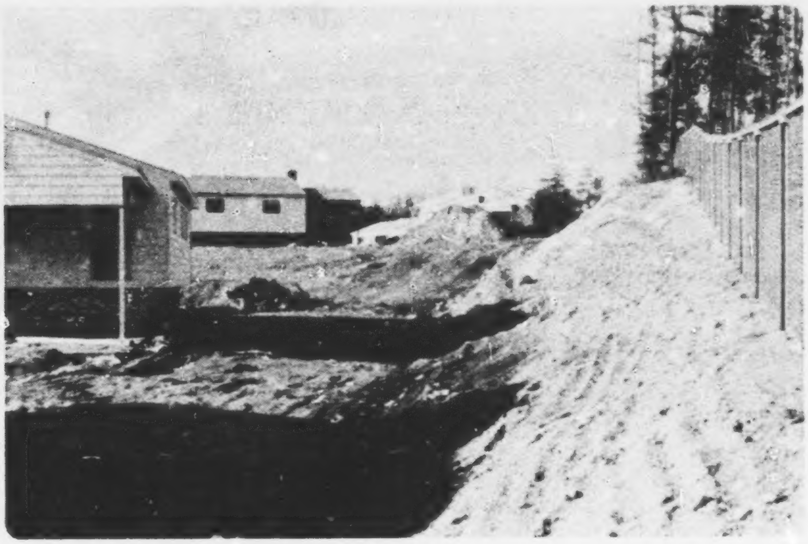


FIGURE D-7. Scarification on slope behind homesites

NOTES:

STUMP REMOVAL

Technical Information

DEFINITION:

Stump Removal is the removal of the stumps of trees that have been cut down to facilitate construction activities, to improve the woodland setting, or because of tree mortality on completed lots or developments.

DESCRIPTION:

The disposition of tree stumps may take several forms. Physical removal using bulldozers, front end loaders, etc., is common. Blasting is still used in some instances. Chemicals are also used when immediate removal is not required.

NOTES:

The removal of stumps by heavy equipment exposes soil to erosion. With the advent of antiburning laws in many areas, stumps must be removed to landfill sites for burial. These two facts make physical removal undesirable. If the removal is required after construction and landscaping have been completed, it is even more undesirable.

An alternative exists in the form of a machine called a stump cutter. It consists of a toothed metal drum that rotates at high speed. When held in contact with the stump, it reduces the stump to chips. The machine can be operated to a depth of about 6 inches, depending upon soil conditions. After the stump has been removed, the woodchips can be used to fill the void and no scar is left to backfill.

The stump cutter is generally available on a contract basis for small jobs. Information may be obtained from local soil and water conservation districts; federal, state, and local forestry specialists; and tree surgeons.

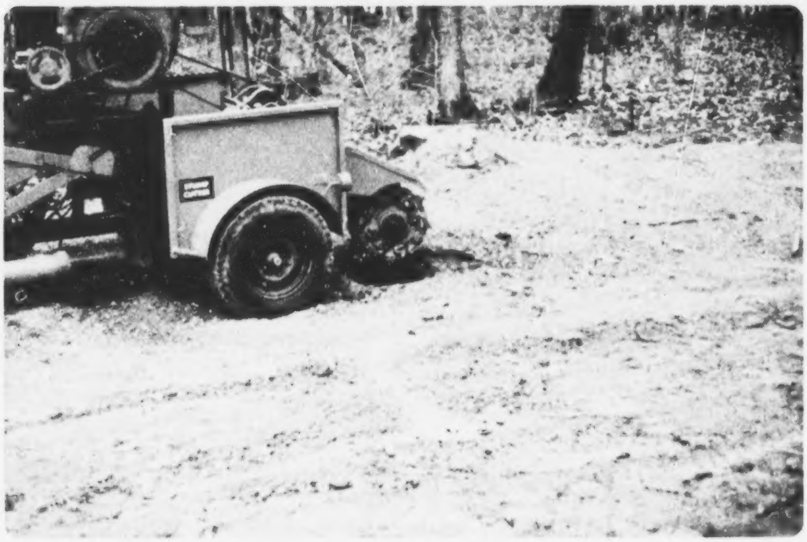


FIGURE D-8. Stump cutter

FIGURE D-9. Stump cutter removing stump

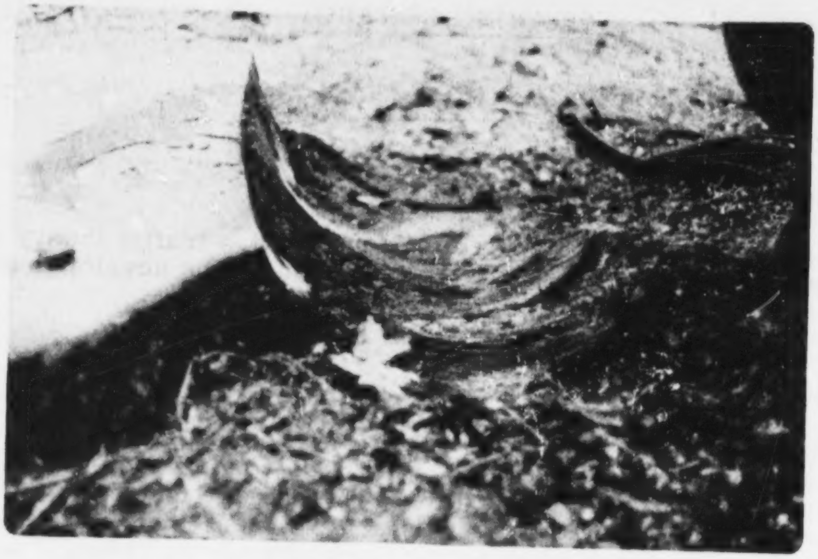


FIGURE D-10. **Stump partially removed by stump cutter**

NOTES:

TRAFFIC CONTROL

Technical Information

DEFINITION:

Traffic Control is the control of construction traffic (heavy equipment, service vehicles, autos, etc.) during the development of a parcel of land.

DESCRIPTION:

Experience has shown that indiscriminate traffic travel is deleterious to any sediment and erosion control program that is instituted at a construction site. The damage caused often influences vegetation and other natural features that would normally endure long after construction operations are complete. An effort must, therefore, be made to eliminate construction traffic from areas where its presence is only for convenience and to control it in other areas. Conversely, any effort to restrict construction traffic from certain areas must be tempered with sound judgment. The work to be done must not be seriously impaired. Avenues or corridors that are required during construction must be established early in the planning phase, and construction techniques must be accurately anticipated so that a workable traffic control scheme can be prepared.

Much is still to be learned regarding this phase of development. The notations that follow can undoubtedly be supplemented by many more. They are presented in an effort to bring this often serious problem to light so that it can be considered in the preparation of sediment and erosion control schemes in the future.

NOTES:

When an area is to be "phase developed" there will often be at least one rather extensive area that will not be immediately graded. If it is vegetated, this vegetation should be maintained as long as possible. If equipment travel is anticipated across this area, a corridor large enough to accommodate any equipment that will be used on the job should be established. Vehicles should not be allowed to drive over the whole parcel. Each vehicle does not have to break a new track across the area. Any traffic restrictions will have to be clearly explained to all supervisory personnel in order that they can relay the word to every equipment operator on the job.

The above is especially true if an area happens to be wooded and scheduled for preservation. It is also true of areas that have been seeded to establish cover for sediment and erosion control. Fencing may be required to achieve these goals.

On large (1/3-acre or larger) wooded home sites, there is seldom a need for equipment travel on the back portions of lots. Trees have their best chance for survival here, and equipment must be excluded from these areas if these trees are to be given the best protection. If it is required to travel from place to place, a route should be established that will stress the area as little as possible. This may require using the roadway "around the block" rather than a direct route through "the back lot."

In wooded areas indiscriminate traffic travel can often be avoided by ensuring that a corridor is available for use. Consider the example where trees have not been removed beyond the top of cut slopes along roadways. Underground utility construction will often completely close the road to other traffic, and other equipment will "cut through the woods." If the clearing were extended another 10-15 feet along the top of the cut slope, an alternate corridor would be provided for use when the roadway is temporarily closed. This extra clearing effort will remove trees that probably could not survive immediately adjacent to the cut slope even if they were allowed to remain.

Vegetation on floodplains must be protected from traffic. These "filter strips" often trap enormous amounts of sediment moving off of construction sites. Their integrity must be maintained if they are to continue to function. In the event that floodplain travel is required, a corridor must be located and travel must be restricted to the corridor.

The absolute avoidance of equipment travel in drainageways is required. Crossings should be established where their existence can be protected. Indiscriminate crossing by equipment should not be allowed. This is especially true in constructed waterways that have been stabilized against erosion and sediment production.

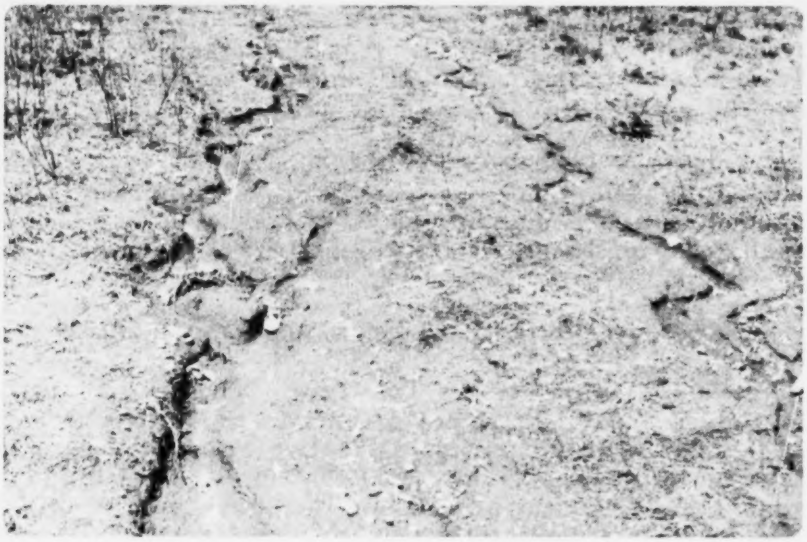


FIGURE D-11. Rills in equipment tracks

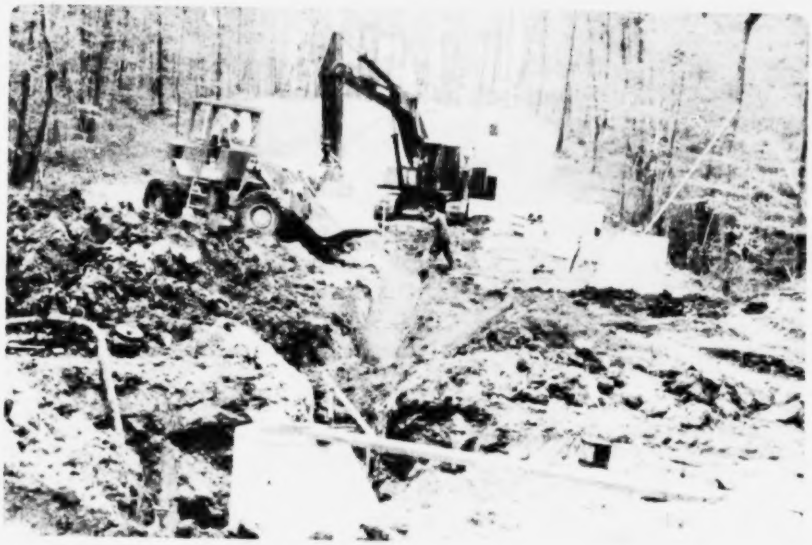


FIGURE D-12. Road completely closed by sanitary sewer construction

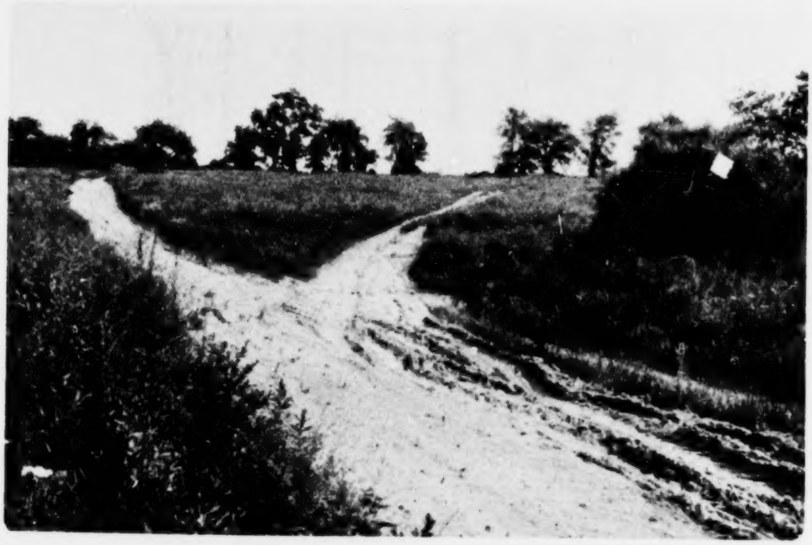


FIGURE D-13. Two routes (one is a convenience route) to same location

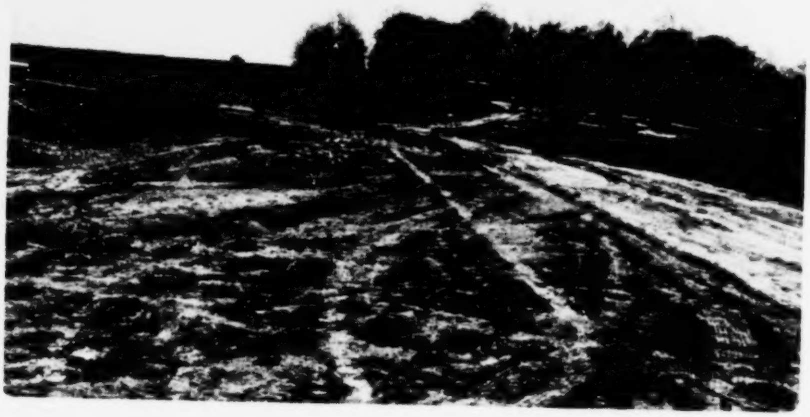


FIGURE D-14. Area completely denuded by equipment travel

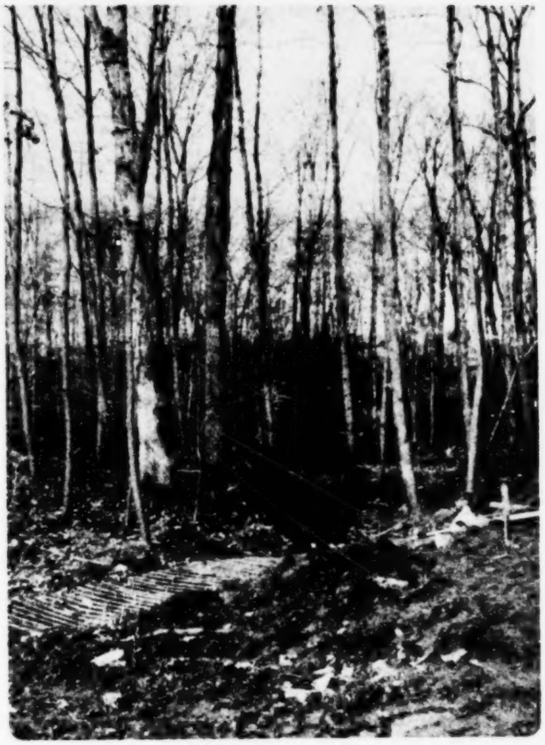


FIGURE D-15. "Convenience" route through a stand of trees marked for preservation

NOTES:

TREE PROTECTION

Technical Information

DEFINITION:

Tree Protection is the protection of trees from damages incurred during construction activities.

DESCRIPTION:

Tree protection can involve protection of crowns, trunks, and root zones from direct damage from construction equipment. The alteration of the water table and conversion of a woodland environment to a parkland environment can also jeopardize the well-being of trees selected for retention on the property being developed. The actual selection of specimens to be saved has an influence on tree preservation in general.

NOTES:

There are many items to be considered under this category. No priority is set regarding their relative importance since each can be of prime importance in the appropriate situation. However, since trees protect the soil from erosion and sediment production, they must be preserved, whenever possible, for erosion control as well as for aesthetic reasons. Some concern is being given to tree preservation as is evidenced by the fences that are often erected around trunks. This protection is generally insufficient, however, unless the fence is erected at the drip line. Generally, a tree's root system extends as far in a lateral direction underground as do the branches of the tree above ground and any protective barrier should be erected to protect the root zone as well as the trunk and branches. Protection inside the drip line is required to prevent against "barking" the trunk, compaction of soil over feeder roots, physical damage to shallow root systems, and the stockpiling of spoil and construction material on the root zone. Exposed portions of trees must be protected from injury since even "superficial" wounds provide avenues for attack by insects and disease.

Cuts for roads and utilities and the installation of under-drains will lower the location of the groundwater table. If the lowering is severe, mature trees may be stressed to obtain sufficient water during certain seasons of the year. This changed condition often results in tree death. If these situations are recognized at an early date, alternative measures may be elected that would be more desirable than the removal of dead trees after construction is complete. A program to artificially sustain these trees may be elected; or, it may be decided that tree removal early in the construction operation is a better alternative than tree removal at some time after construction is complete.

In the case where work must be performed under a particularly valuable specimen, tunneling rather than trenching may be elected in an effort to destroy as little of the root zone as possible. This is, admittedly, expensive; but what is the cost of replacement for a healthy mature specimen?

Filling over tree root zones should be avoided. Trees must breathe and they respire through roots that occupy the zone of aeration in the soil. Filling even a few inches moves the zone of aeration away from the root zone and may cause the tree to die. If filling around trees is required, they may be protected by the construction of dry wells or other devices that will bring air through the fill to the root system. Filling will often bring a tree's root system into the zone of saturation in the soil and the tree will drown.

When selecting trees for preservation, several criteria must be considered. In the case of wooded home lots, where lot size will accommodate some flexibility in structure location, it may be desirable to select the tree(s) that are to be saved and then site the building. This approach will create minimal environmental stress for those trees that are to be saved. Certain species are more desirable than others. Tree health, condition, and confirmation must also be considered and may take precedence over selection on a specific basis alone. Younger trees are often more adaptable to modification of the environment than are mature specimens. For this reason it may be desirable to remove a mature tree and retain several young healthy trees that will more easily adjust to changed environmental conditions.

Removal of some trees will expose the survivors to greater wind velocities. This factor, coupled with some root damage, may cause tree fall during wind storms. Selective tree removal in favor of a single tall specimen may create a lightening hazard.

Intensive gardening is not compatible with root zone preservation and should be considered with all of the other factors when evaluating woodlands for conversion to the parkland environment associated with "wooded" home lot construction.

Unfortunately, there are no simple or general answers and solutions to the potential problems associated with tree preservations. Much research is required in the area of urban forestry. Until such time when answers to these, and other problems, are generally available, evaluations will have to be conducted on a site-by-site basis. Fortunately, professional guidance is available and should be utilized in an effort to recognize potential problems early in the planning of any development.

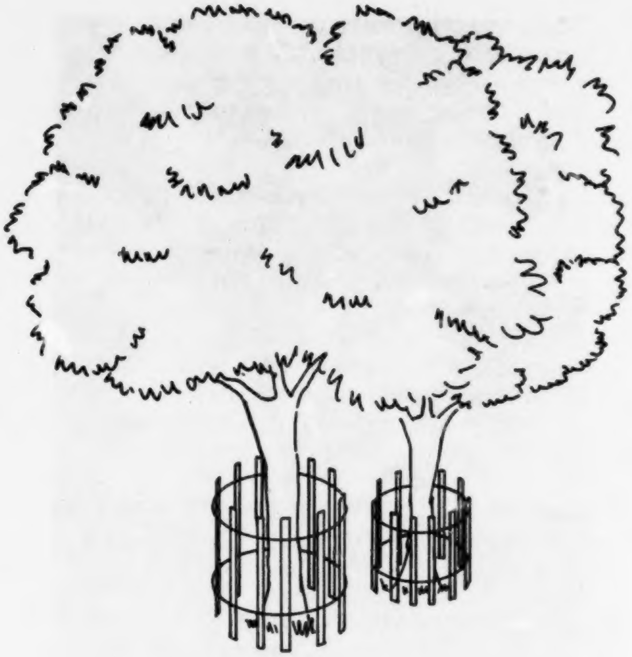


FIGURE D-16. Incorrect fencing for tree protection

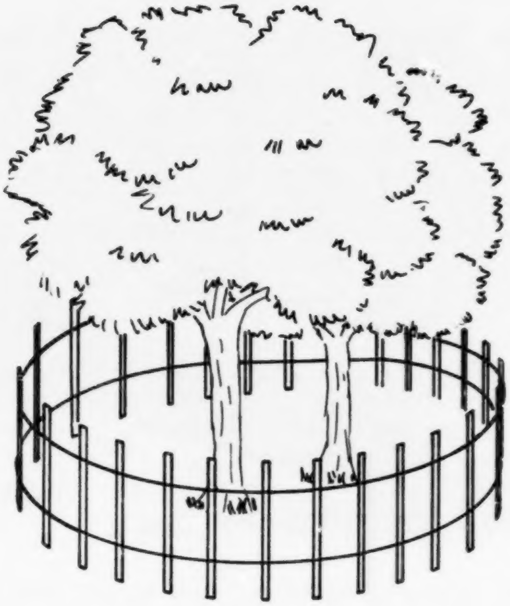


FIGURE D-17. Correct fencing for tree protection

FIGURE D-18. Correct fencing for tree protection

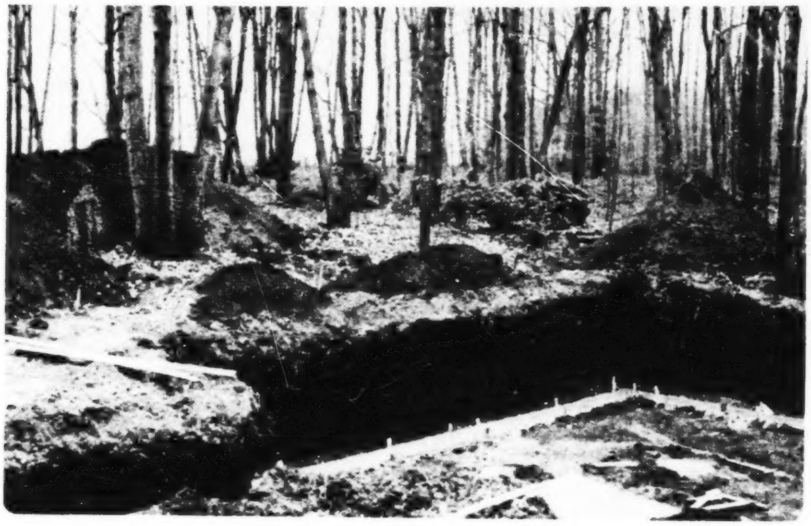
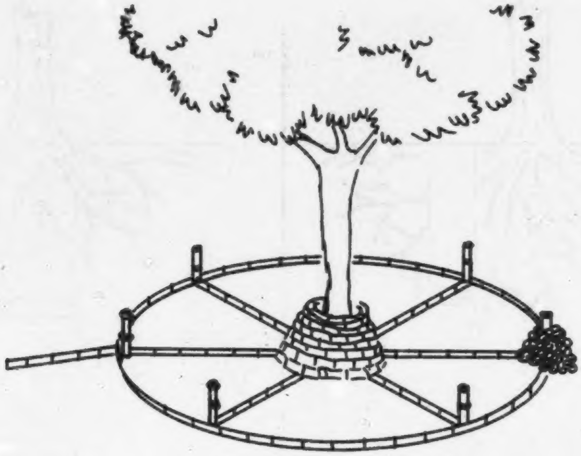
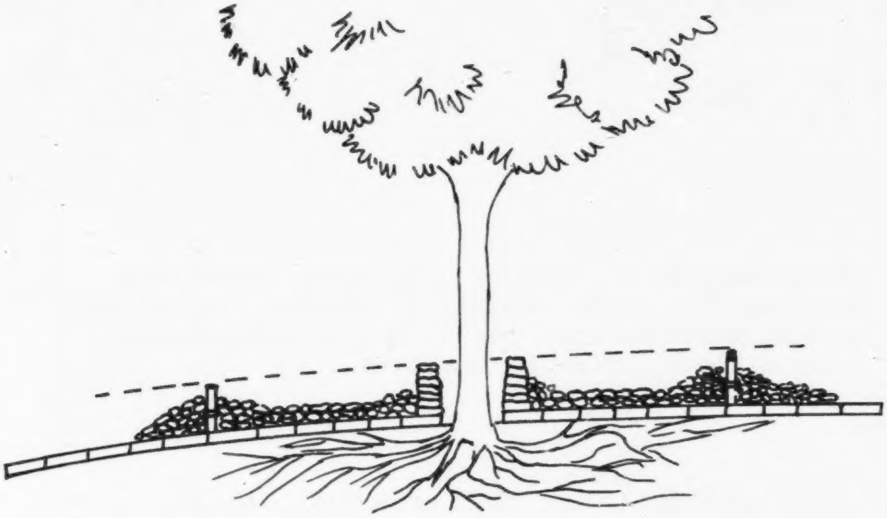


FIGURE D-19. Tree protection - selective stockpiling of soil from basement excavation

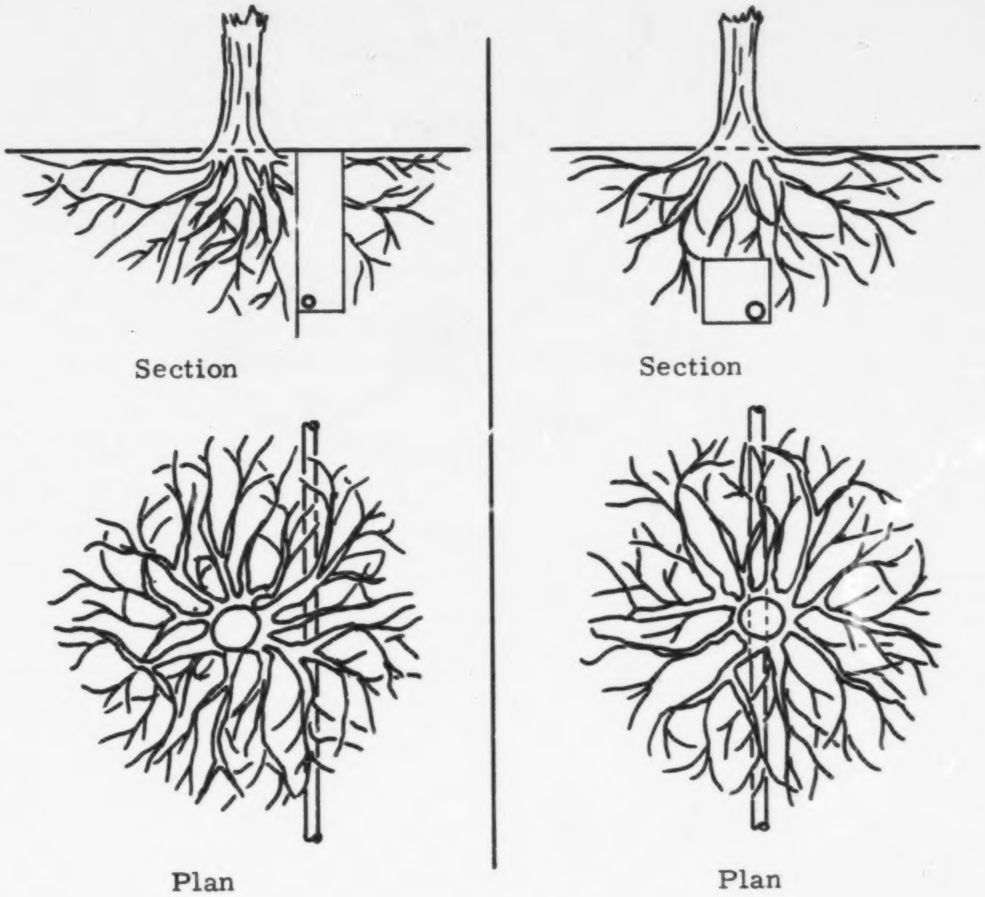


Isometric



Section

FIGURE D-20. Tree protection - tile and gravel will allow air circulation to root zone under a fill


Section
Section
Plan
Plan

Tunnel beneath root systems. Drawings on left show trenching that would probably kill the tree. Drawings at right show how tunneling under tree will preserve many of the important feeder roots.

FIGURE D-21. Tree protection - tunnelling

NOTES

VEGETATIVE FILTER STRIP

Technical Information

DEFINITION:

A Vegetative Filter Strip is an area of vegetative cover through which stormwater must flow before it enters streams, storm sewers, conduits, etc. As the water containing suspended solids flows through the filter strip, some of the sediment is removed by "filtering" and by gravity sedimentation as the flow velocity is reduced.

DESCRIPTION:

Almost any stand of vegetative cover will remove some sediment from water flowing through it. These filter strips can be naturally occurring or man-made and the type of vegetation utilized can be very broad. Best performance is associated with tall, dense stands of turf forming grasses.

NOTES:

The most common, naturally occurring filter strips are those vegetation stands associated with floodplains or found adjacent to natural swales and watercourses. They are also typified by areas across flow routes that remain undisturbed through rough grading operations. Preservation of these areas is all that is generally required for them to function as filter strips. If these filter strips are expected to perform for several months or more, a light top dressing of fertilizer is recommended to improve the stand.

Vegetative filter strips are being utilized during the course of construction operations. As storm drainage systems are completed it is possible to use sod filter strips at storm drain inlets that are not curbline structures. In these cases it is very important that the root zone development of the sod develop as rapidly as possible in order that it will not be destroyed by water flowing into the sewer. It is mandatory that a good "sod bed" be prepared in an effort to establish the bond between sod and soil as quickly as possible. Preparation of the "sod bed" should proceed as if seeding were to be used. The soil is loosened to a depth of 3-4 inches; all rocks and stones are removed; fertilizer, lime, etc., are added and worked in; and the bed is smoothed. The sod is then placed, rolled, and irrigated daily until the bond between turf and soil is firmly established (2-3 weeks).

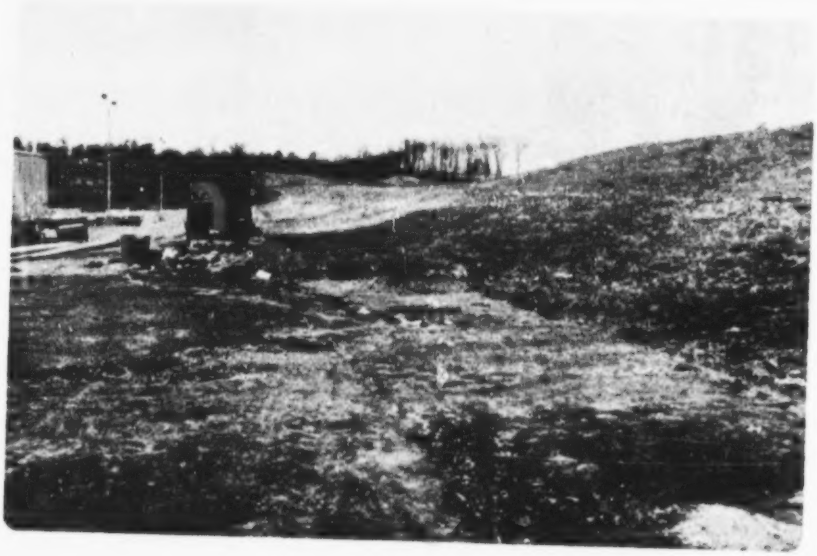


FIGURE D-22. Sod filter strip on stockpile for winter protection

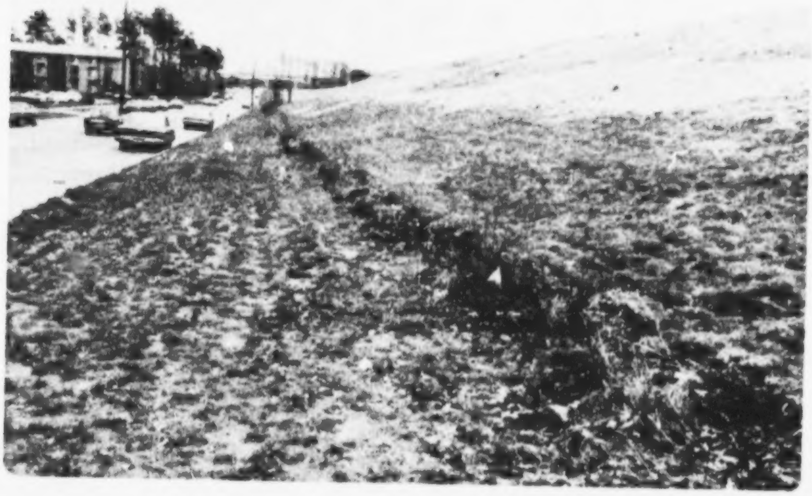


FIGURE D-23. Sod filter strip and straw bales on stockpile for winter protection

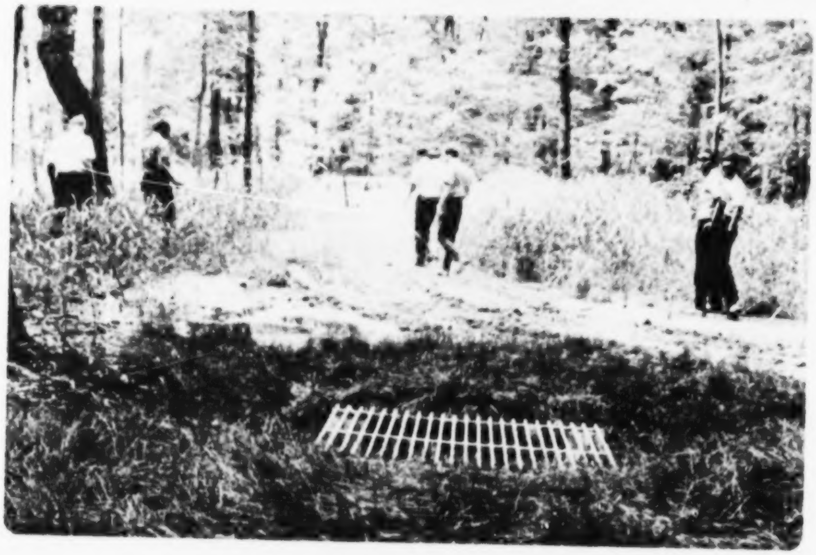


FIGURE D-24. Sod filter strip at storm drain inlet

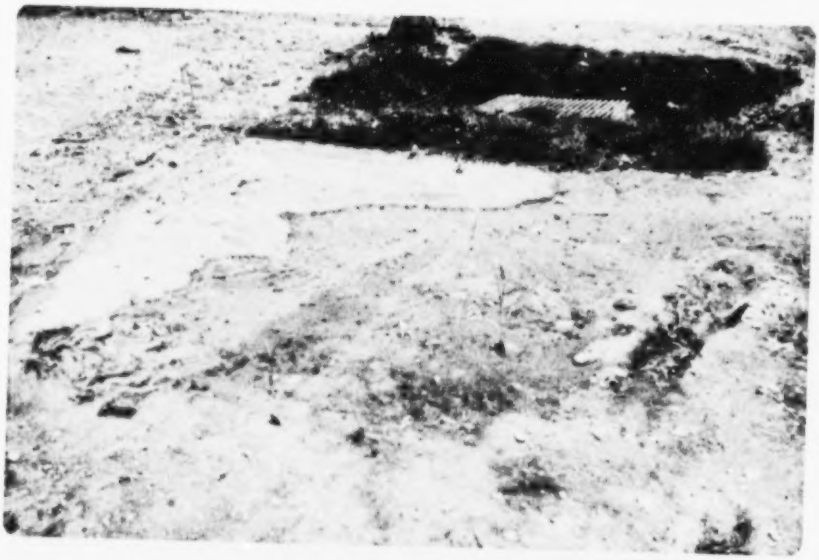


FIGURE D-25. Sediment deposition at sod filter strip

NOTES

WOODLAND CLEARING AND EXCAVATION

Technical Information

DEFINITION:

Woodland Clearing and Excavation involves the clearing of trees from construction sites and the excavation that is associated with construction in wooded areas.

DESCRIPTION:

The results of current applied research in these categories suggests that they can be conducted in a manner that is more compatible with an overall conservation scheme. From a sediment and erosion control standpoint, the removal of any vegetation is deleterious. Where trees must be removed, effort should be expended to complete the work in a manner that is consistent with sediment and erosion control programs. This includes tree and stump removal in ways that will not create additional problems. It includes the use or reuse of the wood products generated during the clearing operation. It also includes the protection of trees that are selected to remain in the future from damage during excavation work.

NOTES:

Disposition of trees cleared from construction operations has historically been accomplished by burning or by removal to landfill sites. Stumps are removed by dozer or blasting. These methods are expedient; they are also inconsistent with current environmental concern.

Wood generated from clearing operations should be utilized. Timber should be salvaged. If the wood is not timber quality, it should be prepared for public or private fireplace use. Material not used for timber or fireplaces should be processed through woodchippers and the product used in sediment and erosion control programs on-site or in adjacent areas (See Appendix C for woodchip use). Although woodchippers in common use today are usually limited to limbs and branches of 4 inches, larger machines are being built and some will be capable of handling all but the largest branches and trunks. Stumps should be removed by "stump cutter" (Appendix C) rather than by dozing or blasting.

Care must be exercised during clearing operations that trees selected for preservation are not damaged (Appendix D). Damage can be imparted by falling trees, equipment travel, and "barking" by heavy equipment.

Construction excavation in wooded areas can be carried out in a manner that will stress remaining trees as little as possible. Spoil should be selectively piled away from root zones. Where it is impossible to pile spoil elsewhere, it should remain on the root zone only a very short time. If it is to be removed from the site, it should be done promptly. If it is to be utilized for landscaping, it should be done promptly. It should not remain piled on the root zone.

Equipment operators digging foundations and basements should not clean their equipment by "slamming" it against the trunks of trees.

If the excavation is wet, professional guidance should be secured when a dewatering scheme is selected. Trenching in the woods is not compatible with tree preservation and should be avoided whenever possible. This is especially true when this type of remedial action is of an "expedient" nature and will be carried out beyond the right-of-way or outside the designated construction area.

Another fact to be integrated into the planning of woodland clearing is that remaining trees will be stressed the least if excavation work is conducted "when the leaves are down." This option is available only in temperate climates where deciduous trees grow. It is, however, worthy of consideration in areas where selected trees will be preserved.

FIGURE D-26. Trees marked for preservation

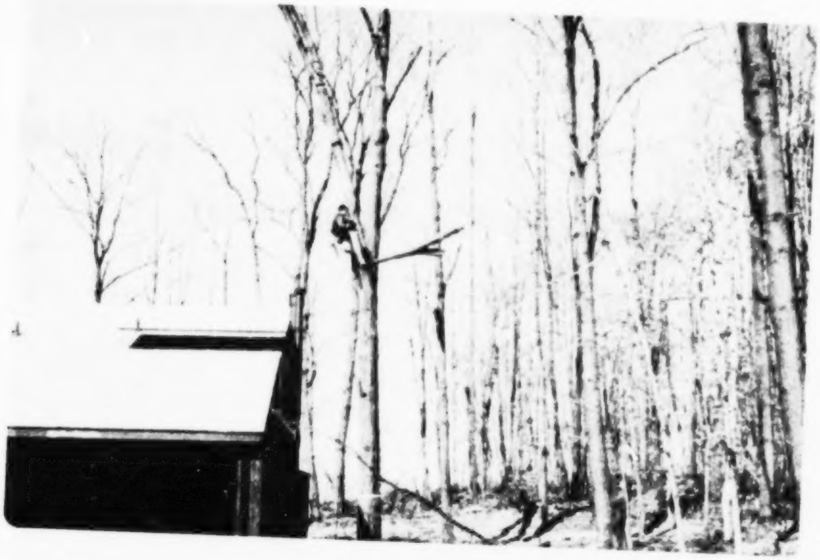


FIGURE D-27. Taking down a tree after home construction. Tree is too close to house and should have been removed when lot was cleared since its root system has been severely damaged by excavation for a basement.

FIGURE D-28. Tree with visible damage. Existing damage should be assessed when selecting trees for removal or preservation.

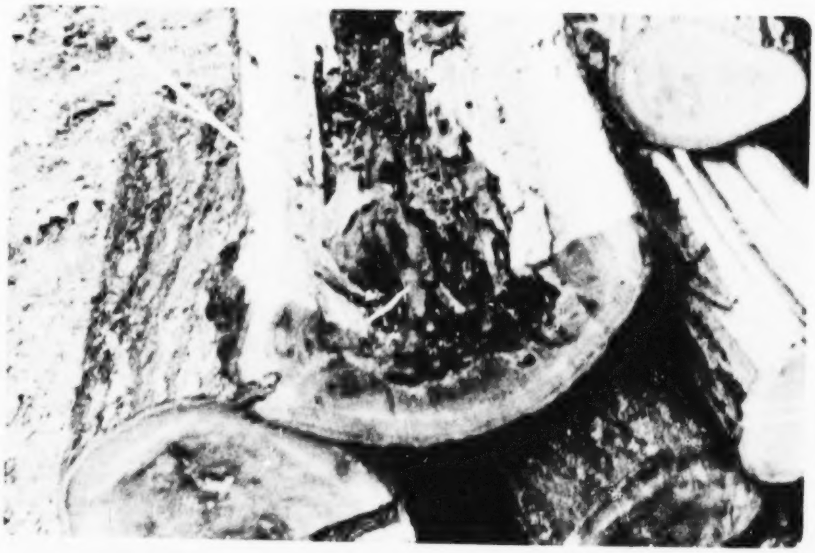


FIGURE D-29. Section of tree trunk (Figure D-28) after removal. Note damage caused by carpenter ants.

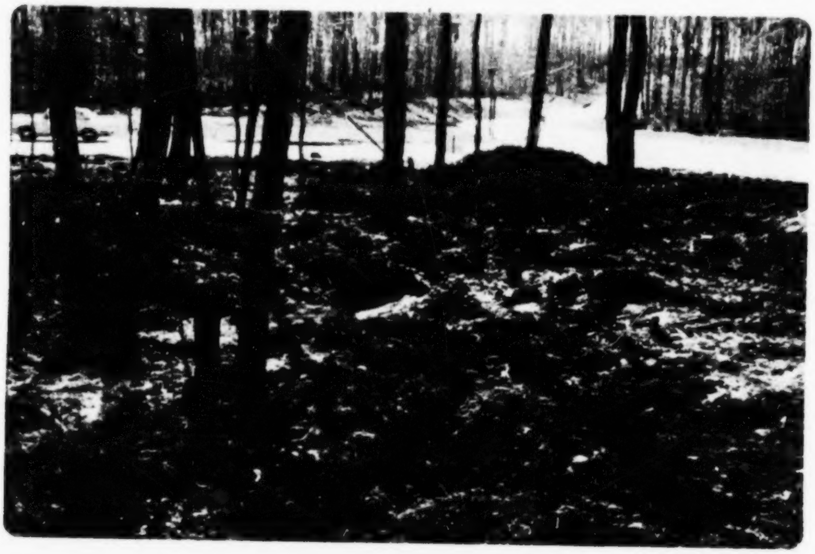


FIGURE D-30. Equipment travel in this area has seriously damaged root systems of trees marked for preservation

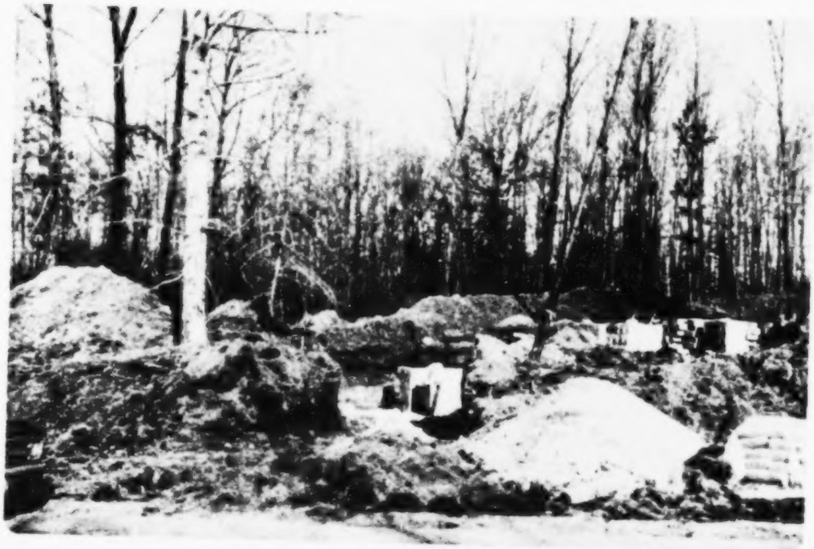


FIGURE D-31. Access route for material delivery to basement has cut roots of beech tree on left

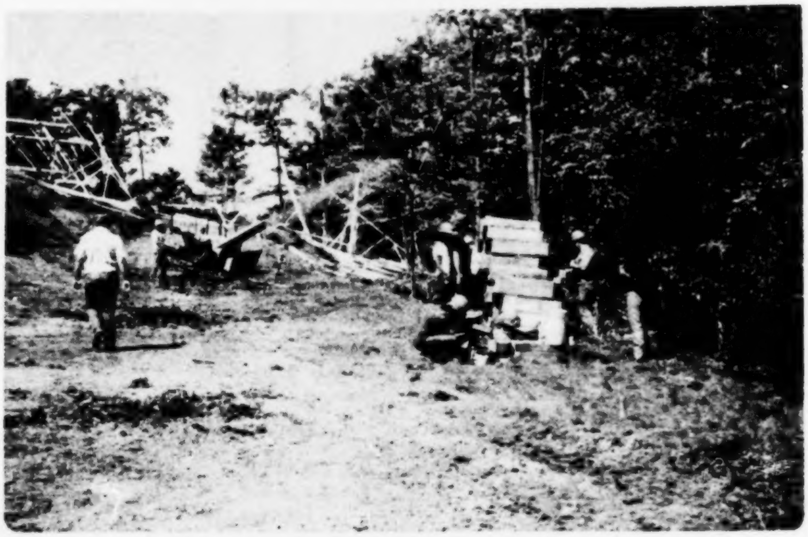


FIGURE D-32. Woodchips being returned to forest

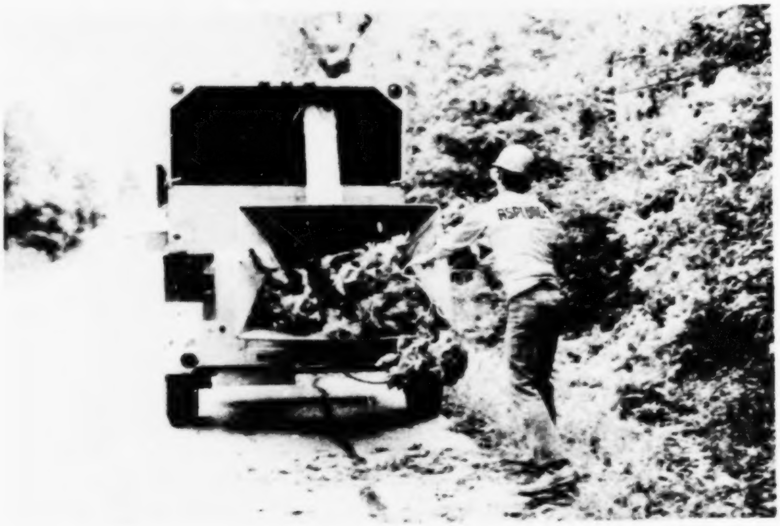


FIGURE D-33. Woodchipper being fed

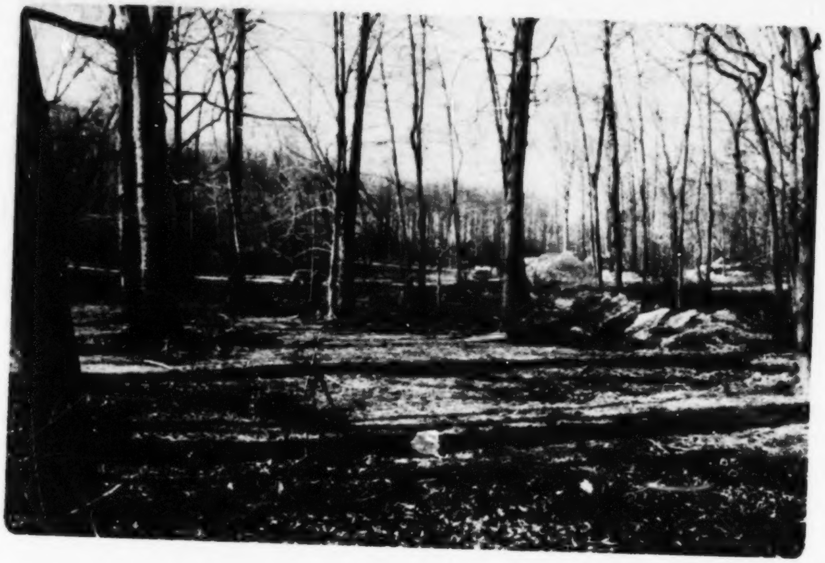


FIGURE D-34. Drainage ditch for "convenience" of utility construction has been cut on private property well outside right-of-way

NOTES:

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